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PHYSALIA PELAGICA.

(THE PORTUGUESE MAN-OF-WAR.)

(With an Illustration in Colours, from a Living Specimen in the Aquarium of P. H. Bird, Esq.)

BY H. NOEL HUMPHREYS.

THE wide range of zoophytic life, comprising as it does so many objects equally remarkable for singularly anomalous organization and exquisite colouring, presents us with no form combining more remarkable structure with a display of more truly gorgeous tints than the singular creature popularly known among English sailors as the Portuguese man-of-war. This beautiful zoophyte, as seen floating—sometimes singly and sometimes in vast numbers—on the tropical seas, attracted the attention of naturalists at a very early early period, though the nature of its structure and its place in natural history were only acurately defined at a comparatively recent epoch. In modern times it has been known among seafaring men of different countries by several such names as the galley, the frigate, or other appellations of similar import, in consequence of the crest which it has the power of erecting along the ridge of the back, which, when caught by the wind, assumes somewhat the appearance of a natural sail, by means of which it seems enabled to glide rapidly over the surface of the water. This, however, is not the case, as it does not move by this means, nor does it appear to possess the power of imparting any special direction to its course, which is entirely at the mercy of wind and wave. Our own sailors probably gave it the more distinctive name of the Portuguese man-of-war,* from first meeting with these creatures about the latitude of the Portuguese island of Madeira.

* Our neighbour, Dr. Julian Evans, informs me that while residing in Madeira, a Portuguese physician inquired of him, with half angry feeling, why this poor, powerless creature, was called by the English a Portuguese man-of-war, and whether any insult to the Portuguese navy was intended? To which he replied that the name doubtless arose in that glorious period of Portuguese history, the beginning of the 17th century, when the Portuguese man-of-war, like the Physalia, was seen on almost every sea.

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The Brazilians call this creature the *mourica*, and the French *la frégate*. The body itself, upon which the sail-like ridge or crest arises, is of a slight semi-diaphonous structure, and has somewhat the aspect of an unusually solid soap bubble, glistening with a more than ordinary amount of iridescent hues.

Although a native of the tropical seas, it is probable that stormy weather, or a long continuation of south-westerly winds, have occasionally carried specimens into the Mediterranean, in the southern regions of which a Physalia might flourish for a considerable time during the summer season, if general circumstances were favourable. It is only in this way that we can account for the knowledge which Aristotle obtained of this singular creature. We know that through the munificence of his patron, Alexander, he was enabled to employ collectors of animals in the interior of Africa and in the far depths of Asia, and in no other way could he have seen specimens of such a vast number of animals of all classes, as he has accurately, or at all events, unmistakeably described. Well-preserved remains of terrestrial animals, and of many kinds of fish, might reach the great Greek naturalist in this manner; but the evanescent nature of the Physalia, which almost immediately loses its beauty on being taken from its native element, would not, after a long transit from distant regions, have reached him in such a state as would enable him to describe it scientifically. So that, unless specimens occur in the tropical parts of the Red Sea, there is no other way of accounting for his possession of fresh specimens. The supposition, however, of the Physalia being occasionally carried into the Mediterranean will explain away this difficulty; and the case no doubt very frequently occurs, as the specimen from which our illustration was drawn had been driven by stress of weather as far north as the coast of the Isle of Wight. In examining or describing a rare and curious form of animal life, it is always interesting, as well as instructive, to retrace the course pursued by successive naturalists, in their endeavours to assign to it a fitting name, and find out its proper place in the scientific arrangement of the animal kingdom. I shall therefore endeavour to follow the labours of successive naturalists in their attempts to define the precise nature of the Physalia. The earliest modern name of this zoophyte, Acalepha pelagica,* or sea nettle, is derived from the ancient name conferred upon this class of marine creatures by Aristotle, in consequence of the venomous sting caused by the poisonous tentacula of several members of the group; a sting which leaves after it a white pimple precisely similar in appearance to that caused by a nettle. Aristotle included in this group the Actiniæ, now popularly known as

* Ακαλῃφη, a nettle, and Πελαγος, the sea.

sea anemones. Pliny, who had probably more abundant opportunities of observing the nature of this singular form of zoophytic life, adopts the name of Aristotle, translating it into Latin, as Urtica marina. Linnæus, in modern times, only knew this zoophyte from the account of it by Sir Hans Sloane, in his description of a voyage to the West Indian Islands, a curious and interesting work, the title page of which announces that it is "*illustrated with the things described, in large copper-plates as big as the life.*" The description in this work is, of course, very imperfect; but the Plinian name, Urtica marina is adopted, which Linnæus changed to Holothuria physalis. The generic term Holothuria was, however, erroneously adopted, under the impression that this zoophyte was more nearly allied than it is to the Holithuridæ, some of which are, like the creature under description, very beautifully tinted with iridescent hues. The specific term physalis, from the Greek, physe (φύση) a bladder, was adopted by Linnæus in consequence of the bladder-like form of the body, by means of which this creature floats upon the surface of the ocean, and this last name, so appropriately invented, is the one by which the genus itself is now distinguished. Cuvier, one of the first great general naturalists who succeeded Linnæus, separated the Actiniæ from the Acalephæ, placing the latter in a separate group, as *Acalephes fixes*, their habit being to adhere to rocks, in a somewhat plant-like manner. But afterwards, following Eisenhardt, he placed the Actiniæ with the Polyps, and then separated the Acalephs into two divisions—*Acalephes simples*, a division including the Medusæ, or jelly-fish, and *Acalephes hydrostatiques*, being those furnished with an apparatus for floating on the surface of the water, in the form of a bladder. The species under description formed the type of the last named group, as Acalepha hydrostatica. The term hydrostatica was not, however, so correct as the simpler pelagica, from the Greek word Πελαγος, the ocean, because it does not float at *will*, by the means of an apparatus under its command, but simply from the reason that its structure causes it to float on the surface of the ocean quite independently of its own volition. Lamarck was the first to determine that the conspicuous bladder-like body was in fact the chief generic character of this singular creature, and he therefore transferred the ingenious and characteristic name which Linnæus had only made a specific one, into the more honourable position of the generic appellation, making our Portuguese man-of-war assume, in scientific classification, the distinctive title of Physalia pelagica, or sea-bladder, which it still bears.

In 1829, M. Eschscholtz, the Prussian naturalist (with whose name every lover of flowers is so well acquainted, through the

medium of the beautiful Californian flower which was named after him, Eschscholtzia Californica), published a most interesting methodical memoir upon the Acalephæ, which he termed *System der Akalephen*, which still forms the basis of more recent systems, and has been followed in the main by Blainville, by Brandt, and also by M. Lesson, to whose work, as the latest, I shall refer again, for the most recent scientific information on the subject.

The first really characteristic representation of Physalia pelagica was that published by Mr. Bennett, as recently as 1834, in his charming *Gatherings of a Naturalist in Australia*. This figure is, however, in some respects not thoroughly accurate, according to the specimen I have so recently seen, and from which the drawing at the head of this essay was most carefully made.

Mr. Bennett, like a truly enthusiastic naturalist, commences the account of his own experiences in connection with the Physalia pelagica, with a few hints on the general richness of the shores of Australia in every form of marine life. Harvey, he tells us, has described above six hundred species of sea-weed, and the total number of the Australian Algæ is estimated at over one thousand. Innumerable forms of zoophytic life, we are informed, exist on those shores which are still unknown, or very imperfectly described, and there are vast numbers of beautiful molluscs belonging to the genera Doris, Tritonia, Eolis, and other genera. Many of the creatures belonging to these divisions of natural history, and which are truly resplendent in their iridescent colours, are found in almost endless variety on the vast shores of Australia; and at Port Jackson, and in the neighbouring bays, it appears that the beautiful Physalia pelagica, or Portuguese man-of-war is frequently found in the greatest profusion; the coast, after a storm, being strewed with heaps of these stranded zoophytes. The inflated oblong bladder, which forms the apparent body of this creature, glows, as Mr. Bennett expresses it, "in delicate crimson tints, as it floats upon the waves." But it is not only with crimson tints that it glows, there are veinings of rich purple and opaline flashes of azure, orange, and green, changing in position at every movement, and its long dependent tresses, or rather tentacles, are of the deepest purple, the rich tone of which is seen even beneath the water. In Mr. Bennett's account we are further informed that the bladder or body in a full grown specimen of ordinary size measures about five inches the longest way, and the long dependent tentaculae are from four to five feet in length, and capable of being extended much farther when shot out for the capture of prey. The bladder is tough, slightly elastic, and semi-transparent. It is rather pointed at one end, which has

been termed the beak, and rounded at the other. Along the highest part of what may be termed the back, forming a kind of ridge, is a crest, which can be elevated or depressed at will, and it is much larger in some specimens than others. This ridge or crest is sulcated and fringed at the edges. The lower part of the vesicle or bladder is of a light blue colour, streaked or veined almost imperceptibly with delicate green pencillings, the crest and beak being of a rich carmine, changing in various lights to a bronzy-green or purple. But these beautiful hues fade very soon when it is taken out of the water, with the exception of those of the long purple tentaculæ, which retain their colour till decomposition takes place.

This singular floating bladder, with its marked crimson ridge, from which purple veinings extend down the sides, might, by a fanciful naturalist, be considered as the primal foreshadowing, or, as he might say, the nebulous origin of the fish form, the dorsal ridge foreshadowing the spine, and the blue veins marking the position for the future ossified radiations. The raised crest might represent the dorsal fin, the cartilaginous beak the position of the bony mouth, while the office of the gills and the ventral fins may be represented by the branchiæ or short tentacles, the air-bladder forming the natural basis of many animals calculated to float in the water. Such a fanciful notion is not altogether extravagant, and in this age of speculative science, some physiologist, wedded to the hypothesis of gradual development, may be found to work out the theory that the Physalidæ are what Laplace might have termed the nebulous stage in the gradual creation of fishes.

It has been said that the Portuguese man-of-war has the power to collapse by the exclusion of a portion of air from the bladder, for the purpose of sinking in the water, as fish do, and that it does, in fact, exercise this power on the approach of storms, when it seeks protection for its delicate structure by sinking to a great depth below the agitated surface. Mr. Bennett, however, positively asserts that it possesses no power of the kind, and that no apparatus can be detected, on the most delicate dissection, by means of which collapse or expansion could be governed. He states that he has seen them, in storms, turned over by the waves, when their great buoyancy causes them to regain their position without effort. He has observed also, in tempestuous weather, that so far from having been able to sink into the ocean depths for protection, they have been cast upon the shore in great numbers, the vesicle still remaining fully expanded. He also found that the air could not be forced out of the bladder except by violently bursting its tough vesicular tissue. The long tentacles appeared to Mr. Bennett to consist of a series of globules containing fluid matter, and hav-

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ing a plate or sucker at the free extremity which these creatures can fix tightly on their prey, not only securing it but benumbing it by exuding a glutinous substance (having a faint odour) which produces that effect. Persons attempting to take up these seemingly harmless and helpless creatures, are soon made to repent their rashness, for the tentacles, with wonderful suddenness, dart their numerous suckers to the hand and arm, inflicting the most painful sensation, which sometimes produces rather serious consequences. Being anxious to convince himself of the precise character of the sting of the physalia, Mr. Bennett seized one by the vesicle, when it instantly raised its long purple tentacles, by muscular contraction of the bands situated at their base, and they entwined themselves about his hand and fingers, inflicting severe pain, and adhering so tightly as to be exceedingly difficult to remove. The stinging sensation continued so long as the minutest portion of the tentacles remained attached to the skin, producing not only local pain, but much constitutional irritation. The pain also extended up the arm, gradually increasing in extent and severity, and seeming to act along the course of the absorbents; the general sensation resembling that of a severe rheumatic attack. The pulse was accelerated, and a feverish state of the whole system was produced, the muscles of the chest being at the same time much affected, and producing, as in rheumatism, a painful difficulty of respiration. Even the secondary effects were very severe, and lasted for more than three quarters of an hour, a certain unpleasant numbness continuing for a whole day. The marks, where the tentacles had adhered, remained for some time longer, and had the precise appearance of nettle stings. The degree of intensity of the pain appears to depend on the age and size of the zoophyte, as does also its duration. The application of cold water has been found to increase the severity of the symptoms, but vinegar or oil appear to afford some relief. The irritating power is retained for some time in the vesicles of the cables after they are detached from the body of the zoophyte; and even linen cloth, used for rubbing off the tightly-adhering portions, was found, when touched, to produce a tingling and pungent sensation.

Mr. Bennett captured great numbers, of different ages and sizes. The older specimens, he observed, had lost the rich carmine tint of the crest, which had assumed a dull orange tone. On taking a Physalia out of the water, it was observed that the bladder quivered with a contractile muscular power, and the beak also, but there was evidently no power of contracting the vesicle or expelling the air. After closely examining the lower appendages attached to the base of the vesicular body, Mr. Bennett arrived at the conclusion that they varied in

form; while Cuvier thought that some of them might serve as suckers, some as ovaries, and the larger ones merely as tentacles. The shorter appendages, Mr. Bennett stated, have no stinging power, and were evidently provided with openings that seemed to perform the office of mouths, through which food was absorbed. These mouths were always expanded, as if seeking prey, at the moment that the long purple feelers were darted out to a great distance to secure an object aimed at, by adhesion, and also by benumbing it. By a strong contractile power, in the exercise of which the long tentacles shortened themselves by assuming a corkscrew form of folding, the prey was brought up close to the mass of shorter appendages or suckers, which, after the manner of polyps, Mr. Bennett conjectured might each be attached to a separate and independent stomach.

Mr. Bennett observed, in a specimen caught in a net, several small fishes benumbed in the entanglements of the long purple feelers. On placing the specimen, together with its captured prey, in a large tub of sea-water, he was able to watch the commencement of the absorbent process. The semi-transparent vessels of absorption showed plainly the passage of portions of the fish, looking like those surgical preparations of the absorbents which, to show their structure more plainly, are injected with mercury, the portions of fish appearing to glisten like silver within the absorbent tubes. He was anxious to ascertain whether these tubes communicated with any central receptacle or stomach, and was induced to consider, after careful dissection, that they did not, but found the tissue of the bladder much thicker where the tubes were attached. The bladder itself he found composed of a double skin, the external one being formed of longitudinal fibres, and the internal one like a cellular membrane, both in appearance and consistence. He found it difficult to cut through the two coats at once, but they were easily separated, and when the outer was taken off, the air did not escape through the inner one, which still remained perfectly inflated. On cutting through a portion of the inner coat, the air still did not all escape at once, as though some delicate internal compartments still safely retained separate portions. In this state it still floated. When, however, he cut entirely through the lower part of the vesicle, the power of floating suddenly ceased, and the tentacles became paralysed. It will be seen when we come to the latest discoveries concerning the Physalia pelagica, that with all his care, Mr. Bennett just missed a part of the structure; the apparent absence of which induced him to believe that each sucker formed in itself a separate system of absorption and digestion. When confined in a tank the Physalia still exhibited all its powers, darting out its tentacles, which seem admirable organs of prehension, and unerringly seizing and benumbing

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their prey in a similar manner to those of some kinds of actinæ, which have also a power, not precisely of lengthening the tentacles themselves, but of shooting forth from them a slender thread to a very great distance, the end of which is so constructed that on touching its destined prey it benumbs it like the tentacle of the Physalia. In several of the Medusæ also, it may be recollected that a similar power is possessed of shooting forth filaments from those dangerous pendent locks from which their name is derived. The Cyanea capillata, for instance, which drifts to the English shores after storms, being one of the most dangerous; and its tawny fibrous mass when seen floating on the water or lying on the beach should therefore be carefully avoided. It appeared also, on watching the actions of the Physalia in the tank, that it had no control over the direction of its own course, which seems to prove, judging from its powers when in confinement, that in the open sea it must be governed entirely by the wind, the wave, or the current.

More recent investigations, however, have induced some naturalists to consider that the suckers, or feeding tentacles, are also to a certain extent organs of locomotion, and that at the same time they act as brancheæ, or breathing organs. It has also been suggested that these creatures, as occurs in several of the lower kinds of animal life, may, in the course of their development, undergo several material changes of form, so as to exhibit at different periods striking differences, not only in their internal structure, but also in their exterior aspect. If such be the case, the Physalia may, as yet, have been described as a complete animal, whereas the expanded, or bladder-form of its existence, may only be its last phase of development, during which several organs may have disappeared, or have been only rudimentary; just as the ventral legs of the caterpillar disappear in the perfect insect, while the wings and antennæ of the butterfly or moth already exist within the body in a rudimentary state. This supposition may serve to explain the different opinions of naturalists on several points of Physalean structure, and for the points of difference described by M. Lesson in his *Histoire Naturelle des Acalephes*, published in 1843, ten years later than the remarks of Mr. Bennett. The principal differences which occur in the anatomical descriptions of these eminent naturalists are, first, that M. Lesson conjectures that the sudden injection of the long tentacles with a fluid forms the principal cause of their power of excessive extension; and secondly, that he actually has discovered a distinct central food reservoir, or stomach, not perceived by Mr. Bennett. M. Lesson states that, running along the base of the air-bladder, which is of much thicker texture than the upper part, he detected a digestive tube covered above by a membranous fold, and

below by muscular tissues attached to the numerous sucking tubes. He describes also a well-defined liver, secreting a caustic fluid. These discoveries appear to prove that the Physalidæ do not belong to the true polyp form, composed of a number of separate existences vitally attached to a central polypidom or rudimentary spine, as in the Alyconium digitatum (Dead-man's Fingers), or to the Pennatulidæ (the curious Sea Pens), but are of a much higher order of zoophytic life, if indeed they are to be classed as zoophytes at all. M. Lesson also gives a more precise account of the various appendages attached to the base of the vesicle than had been attempted before. There are, he says, four simple tubes without mouths, starting like the others from the digestive apparatus; and these he considers strictly breathing-tubes. The rest of the mass of short tubes he considers mouths, and the long tubes simply tentacles, as described by Mr. Bennett. M. Lesson admits six kinds of this class of Analeph, or "Sea nettle;" but to his division of *Cystisomes* (a name which he has framed out of the Greek words *cystis*, a bladder, and *soma*, a body, as being more descriptive of the bladder-body by which the Physalia is distinguished), he only assigns the single species Physalia pelagica, now under description, and which he further distinguishes from the allied kinds by the numerous prehensile tentacles.

Several strange stories have long been in circulation among the West Indian Islands regarding the deadly poisons prepared from the dark purple tentacles of the Galley, or Portuguese man-of-war. Among these, there is a legend that a negro cook determined to destroy his master by putting a small portion of these purple tentacles into some food, which, however, produced but little effect; and he then resolved to dry a quantity, which he reduced to a dark blue powder,—the first dose of which, in some soup, it is said, caused the victim to die in dreadful convulsions. M. Lesson has, however, disproved all these idle stories by actual experiment; the dried substance, he says, is absolutely inert; he has tried it upon dogs without its producing any effect. He has also seen dogs partake of the fresh tentacle, which, while it stung the lip wherever it came in contact with the external skin, was perfectly harmless in the stomach. After a storm, and when a number of Physaleas have been cast ashore, he also states that fowls being fed on them fatten quickly, and that the flesh of fowls so fed proved as wholesome as that of poultry fed in any other way.

Dutertre in his interesting account of the Antilles gives a curiously detailed account of the *galley* or *frigate*, as the French sailors term the Physalia. When full grown, he says the bladder-body is of about the size of a goose's egg, and when the shore becomes crowded with shoals of these creatures, it is, he

says, a certain sign of coming storms. He describes the sensation of the sting as similar to the pain caused by a splash of boiling oil, and recommends brandy beaten up with the powdered berry or nut of the mahogany-tree as the best remedial application, but says that, at best, treatment can do no more than reduce the pain, and that the effect will not, under any circumstances, entirely subside till *after sunset*, considering himself very lucky in having been stung as late in the day as two P.M., so that he had less time to suffer than those who had received stings earlier in the day. Lebbord, in his *Voyage aux Antilles*, gives an engraving of the Physalia, but not a very good one, and Savigny, in his account of the wreck of the "Medusa" describes the agony of sailors seized while in the water by the tentacles of the *ortie de mer*.

The specimen from which our drawing was taken was, it is believed, the first ever seen alive in London. It was obtained by my friend, Mr. P. H. Bird, M.R.C.S., while visiting the Isle of Wight in July last. He heard of an extraordinary creature having been secured by the captain of a trading vessel; and being an enthusiastic naturalist, hastened on board to see the marine wonder, of which very extraordinary accounts had reached him. He immediately recognised it as the Portuguese man-of-war, in whose tentacula a small Smelt was entangled and benumbed in the manner described by Mr. Bennett. Mr. Bird lost no time in making those little arrangements which caused it to change hands, and procuring a large barrel, placed it longitudinally, so as to serve as a temporary aquarium; making other arrangements for the conveyance of his treasure to London, where he looked forward to seeing it disport itself gaily in the large tank in his conservatory in Norfolk Square. The journey was performed under favourable circumstances; but on its arrival many of the long purple tentacles were found to have been worn off by the action of the water against the sides of the barrel; but the shorter appendages were still perfect, and still brilliant in all their opaline tints; while the bladder-body was as magnificent as ever with its iridescent carmine, changing, with every change of light, to green, yellow, or purple. Many of Mr. Bird's friends were fortunate in seeing it in a living state in his aquarium, but, in spite of fresh sea-water obtained every day, its London existence was exceedingly brief, and many who had long wished for such an opportunity of closely examining a Physalea pelagica were disappointed of obtaining a sight of it. However, several drawings were made from the life, and our colour-printed engraving was taken from one made by Mr. Bird himself, carefully compared with another made by a friend, which Mr. Bird considered more perfect in regard to some de-

tails, which he had very carefully observed, but had not defined with sufficient care in his own drawing, owing to the pressure of professional engagements which interrupted him before he could give the last touches to his work. On the whole, our engraving may be considered the most accurate portrait yet published of the Portuguese man-of-war.

HINTS TO BEGINNERS WITH THE MICROSCOPE.

BY T. RYMER JONES, F.R.S.

Few things are more discouraging to the student when first entering upon microscopical research than the frequent disappointments he has to encounter in his endeavours to procure living subjects for observation. He reads the instructions usually laid down in works upon the microscope, provides himself with a multiplicity of apparatus, landing-nets, jointed rods, phials with elaborate contrivances for their attachment and detachment, cases of bottles, and corked tubes, etc., and yet when he gets to the water-side, too often finds that, with all his appliances, he is unable to procure the creatures of which he is in search, reminding us forcibly of those amateur fishermen to be seen on the banks of every river, armed with all the paraphernalia procurable in London, and yet unable to catch a single fish, while the poor ragged lad who accompanies them, furnished only with a rod and line of his own rude manufacture, soon manages to fill his basket.

We ourselves, in our younger days, enthusiastic though we may have been, found our ardour very considerably damped when, after a walk of twenty miles, we have returned wearied, as from a day's shooting, with nothing but experience for our pains, whilst, as we now know, every object of which we were in want was easily obtainable in the nearest pond, had we but understood how to set about procuring it. We write not, be it remembered, for scientific readers, some of whom, perhaps, may smile at the simplicity of these remarks; our advice is addressed to the beginners with the microscope, who will probably be benefited by the following suggestions:—

Let us suppose that the young naturalist sets out in search of infusorial animalcules, furnished *secundem artem* with a dozen bottles, to be filled with different kinds, and is told to procure samples of the water from each place that he visits likely to contain these invisible atoms: he does so, but when he gets home in the evening to his microscope, however much better he may be for the exercise, he finds himself woefully taken in when he comes to examine the contents of his several phials; for,

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notwithstanding all that has been written about the astounding numbers in which Infusoria exist and their universal distribution, the probabilities are, that in his whole collection he does not find a dozen specimens worthy of attention.

True it is that in stagnant water wherein animal or vegetable substances in a state of decay abound, certain forms are met with in numbers absolutely incalculable, *Monads, Spirilli, Euglenæ*, and others, now by general consent referred to the vegetable kingdom,—thousands of these crowd every drop of the fluid containing them; such, however, is by no means the case with the more highly organized forms of which the microscopist is generally in search, their presence is almost exclusively restricted to the immediate vicinity of the plants they frequent, and on which they are found as numerously as sheep in a pasture, wandering over their surface by the agency of their cilia (*Paramecium, Kolpoda*, etc.), creeping along their stems by means of hooked leg-like appendages (*Himantopus charon*, etc.) attached to them by highly irritable stems, which shrink from the slightest touch (*Vorticella*), or sometimes forming a very garden of living arborescences; if, therefore, instead of bringing home bottles of the water, the caterer for the microscope were to procure but a very small quantity of the verdure skimmed from the surface of the pond, we will venture to say that he would secure variety of specimens and abundance of delightful recreation.

There are, moreover, particular plants which are preferred by certain species, and on which they are almost exclusively found. The floating duck-weed, for example, is the favourite resort of *Vorticella, Stentors*, and the larger species of Infusoria, as well as of whole tribes of other interesting microscopic creatures. This, however, should be obtained from a clear pond, and from undisturbed water; some quiet little spot, situated in the corner of a field, for instance, from which boys and cattle are excluded, and to which the sunshine has free access, not very large, but deep enough to allow of the growth of the larger aquatic plants. Such a locality is an invaluable adjunct to the microscope. The sportsman may rent his moors and the angler his streams for the sake of a few grouse or trout—we envy him not—a table-spoonful of the duck-weed skimmed from such a pond is worth all the moors in Cumberland to one who prefers the society of his microscope to the companionship of his pointer or his fishing-rod.

Suppose, again, that *Hydræ* or the *Polyzoa* are the objects sought after. To expect to find these in water taken haphazard from the pond is a very precarious speculation; by fishing up, however, some of the sticks which testify by their appearance that they have been floating about for months, and

scraping them with a pen-knife, or, better still, stripping off portions of their bark, the collector will be pretty sure, in favourable situations, to procure the objects of his search; or thin slices may be shaved from the exterior of submerged piles. Any or all of these taken home in a jar of clear water will be sure to afford materials for study.

The leaves and stems of the water-lily are the favourite resort of many beautiful species, and on them may be likewise found the eggs of several kinds of insects and mollusca. To obtain these some pains must be taken at the water-side: the leaves should be gently placed with their under surface uppermost in a wide saucer, or shallow dish, filled to a little depth with the clear element, and after remaining undisturbed for a short period should be examined with a pocket lens. Should anything be found worthy of preservation, the part to which it is attached may be cut out with a sharp penknife, so that it may be more easily and safely carried.

By far the most fertile field, however, and one to which we would specially direct attention, will be found in those confervoid growths that in summer time mantle the ponds, covering them with a sort of green carpet, composed of a thick felt, made up of interlacing fibres of such tenuity that it may almost be compared to the pulp from which paper is manufactured. Whoever has watched in early spring the gradual formation of this wonderful growth, will understand at once how valuable a resource it affords to the microscopist. During the winter season, in truth, our ponds are desolate enough; animal and vegetable life seem quite extinct; and whilst the "snow-broth" is on the waters it is almost superfluous to recommend our young friends to employ themselves at home in grinding thin sections of anything rather than expose themselves to chilblains, benumbed fingers, and bad colds. No sooner, however, does genial spring again call forth latent vitality, and the returning sun shines brightly on the water, then, as by general consent, nature revives—green tufts appear, in which the younglings of the year find refuge, and to these alone the naturalist should have recourse. Every little bunch of young confervæ gently gathered from the surface of a stone, will at this time be found to swarm with nascent beings, or with creatures in their tenderest stage of early growth, while in the water all around no living thing is met with. As spring advances, vegetation spreads over the bottom of the pool, confervæ of all kinds begin to multiply with such rapidity that, rising like a cloud, they tinge the water red or green, according to the colour they assume. Few people trouble their heads about the growth of these confervæ, or suspect the miraculous combination of circumstances upon which their rapid increase depends.

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They are composed individually of thread-like filaments, made up of cells or microscopic segments, filled with vegetable granules; every microscopic cell as it becomes mature divides into two young ones, and those thus formed divide again, and thus from hour to hour this process of division is repeated.

We are all familiar enough with the prodigious results obtained by continually doubling the product of any given number even as many times as there are nails in a horse's shoe or squares upon a chess-board, and know that by this process we soon arrive at arithmetical expressions far beyond what our minds can appreciate—millions and billions, and other numbers which it is easier to talk about than to comprehend—and yet how inadequate are sums like these to express the increase of the progeny of the confervæ, during a single day, by this process of spontaneous fissure!

These confervæ, moreover, have another mode of reproducing themselves which is even still more prolific and more wonderful. The cells of which they consist are individually capable of forming progeny in their interior from which similar growths are developed. When a portion of one of these organisms is examined under the microscope, its cells may at certain periods be observed to contain numerous spherical granulations which, as they approach maturity, become pear-shaped, and provided at one extremity with a little rostrum or beak, their body is filled with a green material (*endochrome*), and they generally exhibit a minute red spot, once described as an eye, but now recognised to be a globule of oil. As these germs become perfected they may be seen moving restlessly about in the interior of the cells in which they were formed, striking the walls of their prison with their little beaks, as though anxious to get free. At length the walls of the cell become ruptured and its liberated contents escape into the surrounding water, through which they speedily begin to move hither and thither with astonishing rapidity—now progressing in a straight line, now wheeling round and round, and, anon, lowering their beaks they begin to oscillate upon them like peg-tops waggling just before they tumble down. Sometimes they stop altogether and again resume their curious and eccentric movements. After two or three hours of such exercise, their motion becomes much retarded, and at length, after faint struggles, entirely ceases, and the little *zoospores* lie as though they were dead; the vital principle, however, is still active within them, they soon may be seen to expand in their dimensions, to become partitioned off internally, and finally to send off two or more rootlets by which they become attached and stationary. Strange transition, from the roving life of an animal to the fixed condition of a plant!

Possessed, as the confervæ are thus found to be, of limitless powers of reproduction, it is no longer surprising that they spread through the water in every direction, and at length reach from the bottom quite to the surface. As the heat of summer increases, the scene changes—the dead cells, emptied of their contents and filled with air rarefied by the heat, become at length buoyant, and the whole mass rises slowly to the surface carrying with it, entangled in its meshes, innumerable hosts of microscopic beings, all of which find food and shelter in the recesses of the floating mass, while the water of the pond is left comparatively destitute of living inhabitants. The principle upon which the microscopic contents of the water are thus collected together is very similar to that adopted in clarifying liquids by means of the white of an egg; the albumen in its fluid state is first equally diffused through every part; it is then coagulated by heat, and mounts to the top bringing all impurities with it, and leaving the liquid below quite clear and pellucid.

During almost the whole of the last summer our only fishing ground has been the round pond in front of the palace in Kensington Gardens, the surface of which has been covered with a scum composed of these confervoid growths: of this we have at the present moment a small jar before us which, for a whole week, has afforded us an inexhaustible supply of microscopic forms, endless in variety and most interesting in their character. We will place a little of it under the microscope merely for the purpose of enumerating the organisms which it may chance to contain:—*Desmideæ* and *Diatoms* present themselves in rich abundance; a few splendid *volvoces* roll about in stately leisure; *gonium pectorale* shows itself in all stages of development. There are at least twenty species of cilated Infusoria; two or three gorgeous specimens of *Actinophrys;* several kinds of Rotifers, young Planariæ and various Entomostraca of all ages, *Hydra fusca,* many minute larvæ of insects, and two or three specimens of *Nais proboscidea.* Such is the microscopic wealth contained in a minute bunch of confervæ taken up at random. We might have brought dozens of bottles of water from the same pond without obtaining a specimen worthy of examination.

These remarks are merely intended as hints to guide the beginner in his first researches. All that we wish to insist upon is, that microscopic animals are always more or less associated with aquatic vegetation, upon or in the vicinity of which only they are to be obtained with any degree of certainty.

XUM

THE FUNGUS FOOT OF INDIA.

BY THE REV. M. J. BERKELEY, M.A., F.L.S.

EVERY advanced practitioner is well aware of the immense influence which fungi exercise in the production or aggravation of disease in the animal as well as in the vegetable kingdom. A hundred memoirs or more might be quoted bearing more or less directly on the subject, besides the great work of Robin; but unfortunately, in a few instances only, the persons who have recorded their experience have been sufficiently acquainted with fungi in general, to give anything like a complete history of the cases which have fallen under their observation, even if proper leisure was available for researches which require not only time, but continuous attention. Mere mycelia have in consequence been described as perfect plants, mistakes have been made in important points of structure, and productions of an undoubted fungoid nature been referred to Algæ, though agreeing with them neither in habit nor physiology, while the commonest moulds have received new names, and several conditions of the same species have been registered as autonomous productions.

One of the most curious and important cases of disease produced by fungi which have hitherto been recorded, is one on which a report was made in March 1860, by Dr. H. Vandyke Carter, the Professor of Anatomy and Physiology at the Grant Medical College of Bombay, a disease which unhappily occurs in many parts of India, and is known amongst Indian practitioners as the Fungus Foot, or Fungus Disease of India, or under the scientific names of Podelcoma or Mycetoma. This disease, which has hitherto occurred amongst natives only, is undoubtedly due to the presence of a fungus which eats into the bones of the lower extremities, including the base of the tibia and fibula, and in process of time causes death from exhaustion, unless a timely amputation is made above the diseased part.

Dr. Carter kindly forwarded to me his original memoir immediately after its publication, accompanied by illustrative specimens preserved in alcohol. He has since had an opportunity of investigating other cases, which have enabled him to make some additional observations, recorded in the seventh volume of the *Bombay Medical and Physical Society's Transactions*, in which he was materially assisted by my friend, Dr. H. J. Carter, whose labours as an acute observer and physiologist are well known in this country as well as in India. The latter gentleman has placed at my disposal his notes and

sketches, and I am therefore in a condition to lay before the reader of this Journal, so far as it may be interesting to the non-medical world, a summary of a most curious matter, and one which at the same time is peculiarly suggestive.

As the fungous matter assumes various forms, it will be well, in order to avoid confusion, to notice the most prominent separately, taking the most typical first.

1. The first case, then, is that in which the bones of the foot and the base of the leg bones just above the ankle, for the disease never ascends higher, are perforated in every direction with roundish cavities, varying in size from that of a pea to that of a nut or pistol bullet, the cavities being filled up with a dense fungous mass of a sienna red within, but externally black and resembling a small dark truffle. From these cavities, canals lead to the surface, from which a purulent fœtid discharge is poured out, often accompanied by little pieces of the fungus. The masses and granules are imbedded in a whitish semi-opaque glairy substance of homogeneous consistence, while the walls of the canals have an opaque yellow tint, and are readily torn. The whole of the surrounding softer parts are converted into a gelatiniform substance, taking the place of the muscles, the tendinous and fatty structures being less readily changed. The foot presents externally the peculiar turgid appearance which it so often assumes in bad cases of scrofula. Besides the canals, pink stains or streaks are observable on the skin, and penetrating the subjacent tissues, filled with spherical or ovate groups of minute bright orange coloured particles, and containing occasionally a few larger cells, the nature of which has not at present been ascertained, though it is conjectured that they present the earliest appearance assumed by new attacks of the disease.

Of the structure of the large truffle-like bodies I am enabled to give an excellent figure made by Dr. H. J. Carter, from a case which he examined immediately after amputation, and which is of course far better and more satisfactory than any which could be made from the preserved specimens. The parts in which the structure is most visible present precisely the characters of a true Oïdium, such as *O. fulvum* (fig *a*, p. 255). Short beaded tawny threads arise from a common base, consisting of cylindrical articulated filaments, having at their tips large spore-like cells. These, however, do not appear to germinate *in situ*, but to become enormously dilated, their albuminous contents assuming at length a resinous consistence, while many of them burst, and nothing remains except fragments of the old cell walls. The resinous matter is inflammable, but its exact chemical nature has not yet been ascertained.

If, however, these large terminal cells be a form of fruit,

they are not in all probability the only form, for on three occasions the black fungous masses, either in maceration in water, preserved in alcohol, or scattered purposely on rice paste, to see if any further development would take place, gave rise to a peculiar mould, which it can scarcely be doubted is the perfect condition of the species, though at present it has not been observed in any other situation; a circumstance, however, which need excite no surprise, as so little attention has hitherto been paid to the minute fungi of India. Further observations will, I doubt not, demonstrate immediate connection with the disease. Of this fungus I am enabled meanwhile to give a sketch from Dr. H. J. Carter's original drawing, and its beauty and singularity are both sufficient excuse for its reproduction in this place. The change from the early yellow or colourless transparent threads and sporangia to a fine red or crimson, make it a most lovely object for the microscope.

The fungus made its appearance only in the months of April and May. I have great hopes next spring that I shall be able to cultivate the species myself from specimens placed in my hands, as so many moulds are grown with the utmost facility on rice paste, which affords an admirable opportunity of examining them in every stage of growth, proper caution being taken not to confound different species with each other, as several will sometimes appear together, or in succession on the same mass of paste.

The fungus resembles closely the genus *Mucor*, but there is no columella in the sporangium—a character which accords with Chionyphe rather than with Mucor. Indeed I do not see a single character in which it differs generically from Chionyphe, though the two recorded species occur only under snow. It is very possible, however, that the proper habitat of our fungus may be upon damp soil. It consists of a thin filamentous stratum spreading in every direction over the paste, so as to form little slightly raised patches (fig. *d*, p. 256). The threads which are about 1-5400 of an inch in diameter, are more or less branched, and contain masses of grumous matter which give them an articulated appearance. These masses pass from a bright yellow into red. Short lateral branches from the mycelium give rise to a globose sporangium, which at first contains a single nucleus, but as it grows exhibits different phases of cell formation, and finally gives rise to short subfusiform spores, each of which contains a nucleus or oil globule at either extremity. The sporangia, which attain sometimes a diameter of 1-400 of an inch, like the mycelium, change from yellow to red, but some apparently are colourless. The spores when ejected germinate very rapidly, giving rise to fresh threads, which are at first perfectly straight. Some of the threads

of the mycelium, and probably the younger, are distinctly articulated, and in this case there is uniformly a nucleus or oil-globule at the upper extremity of each articulation, near to the dissepiment. The sporangia are sometimes covered with a network of threads, the exact origin of which is at present obscure, but the same appearance occurs in *Mucor stolonifer*, Corda, which often accompanies our Chionyphe on the paste (fig. *e*, p. 256).

The species may be characterized as *Chionyphe Carteri;* hyphasmate ex albo flavo-rubroque; sporangiis demum coccineis; sporis breviter fusiformibus.

The name will serve to record the labours of the two Carters, united in their love of science though not in consanguinity, and there will be something of the same economy as regards nomenclature as that of which Ovid speaks with reference to a double birthday, "Una celebrata est per duo liba dies."

Before passing to the other forms, I must add a word about the pink streaks mentioned above. It is highly probable that many of our common moulds occasionally commence with a similar condition. The first indications of vegetation on tainted meat or paste assume the form of little gelatinous spots of various colours, consisting of extremely minute distinct cells, and these seem to be an early stage of common species of Aspergillus and Penicillium, or other genera. If there be any truth in the notion which I have entertained for some time, that hospital gangrene depends upon some vegetation of this nature acting as a putrefactive ferment, there may be good reason for believing that the red spots in question are really the commencement of the disease under consideration.

2. We now come to a second form under which the disease appears. In this the black fungous masses are entirely wanting, and in their stead masses are found of what looks like sloughing tissue. White granules, however, occur in the cavities and in the discharge, which appear to be a form of the same fungus, though the identity has not been proved. Under the microscope it wears the appearance of a congeries of large cells filled with smaller, much after the manner of *Microhaloa firma*, as figured by Kützing (fig. 1, p. 252). The accompanying sketch, after Dr. H. J. Carter, represents a portion after immersion in sulphuric ether. According to Dr. H. V. Carter, these bodies have moniliform threads on their surface, but these I have not seen. Whether the perfect form of the plant be the same or not, the phases of the disease produced by it are exactly the same, and the malady admits of no other remedy.

3. A third case is known under the name of the Madura foot, from its having occurred at Madura. In this case the foot becomes enormously enlarged about the instep, though not so

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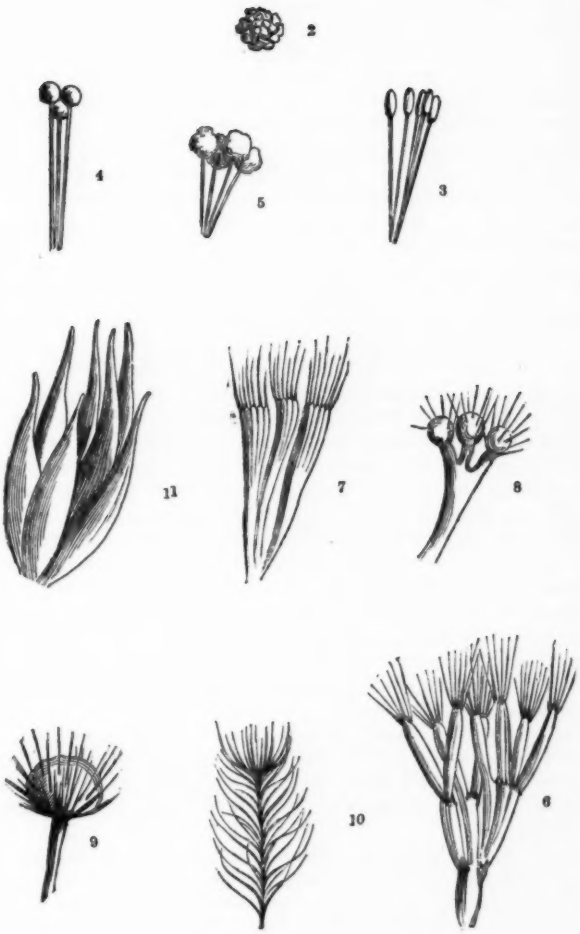
much at the ankle, while the toes are hypertrophied, and almost lost or imbedded in the mass. The small bones are nearly destroyed, leaving behind a pallid or reddish tissue, while the others are more or less excavated. There are the same canals and external sanious apertures. In some parts they are filled with the same fleshy tissue, in others lined with it, where large cavities are formed by the junction of several canals containing broken up osseous tissue from the exposed bones around, grey fragments and masses of pigment. The pink colour is partly owing to a general diffusion of pigment which tinges the oil-globules, and partly to the presence of very numerous single or

1

aggregated elliptic particles. These granules are from the fiftieth to the 1-130th of an inch in diameter, and occur sometimes as single ellipses, sometimes as two combined at the extremities of their major axes, and sometimes as square bodies with rounded extremities divided crucially into four. They do not seem to be cells, at least cells of cellulose, containing a grumous mass, but resemble rather certain Palmellæ. They are quite visible to the naked eye, insomuch that when the sawn surface is first exposed to view, it appears as if strewed with grains of red pepper, and pains were therefore taken by Dr. Carter to assure himself that they were not particles accidentally introduced through the open window. Further examination convinced him that, though different in colour, they were similar in essence to the granules described in the second form. None of the black fungous masses appeared, but there were globular opaque bodies of various size which now require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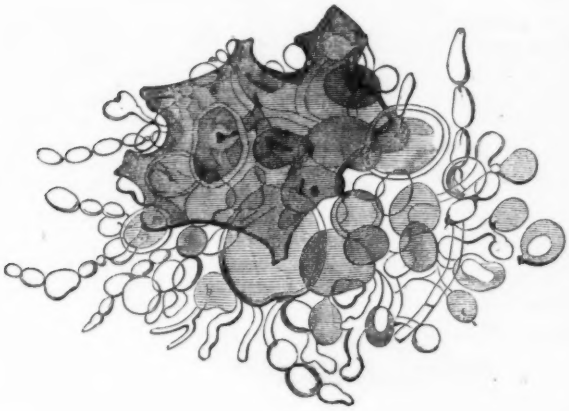
notice, and which, though at first apparently so different, are closely connected with the fungus of the first form.

The foundation of these bodies, of which one is represented, slightly magnified, at fig. 2, consists of one or more large mother-cells filled with a mass of daughter-cells as represented in the plate at p. 256 (fig. *b*, *c*). These are clothed externally with a radiating growth assuming a vast variety of forms, some only of which are here represented from Dr. H. J. Carter's sketches. The structure often so exactly simulates that of minute moulds, that it is very difficult to get rid of the notion that they are really vegetable growths. Pure sulphuric ether, however, dissolves them completely, and shows that they are merely different forms assumed by stearine. Sometimes the white mass consists of straight slender threads radiating in every direction, each of which is surmounted by an elliptic spore-like body (fig. 3), or by a regular globe (fig. 4), while occasionally the threads or crystals are shorter and the globe irregular (fig. 5). Sometimes the globules are absent, and in one case the fundamental cell budded like the receptacle of an aspergillus (fig. *e*, p. 256); each new cell being separated by an articulation and supported on a short stalk, as represented in the plate. Sometimes the outer coat consists of regularly dichotomous or trichotomous fascicles of linear crystals, which are free above (fig. 6); sometimes, on the contrary, the fascicles are dilated above with ciliary processes (fig. 7), or occasionally lobed (fig. 8); while occasionally there are straight radiating bodies surmounted by a globular mass, pierced and surrounded by cilia, after the manner of volutella (fig. 9). Another form appears under the guise of little feathers (fig. 10), while a not unfrequent one consists of leaf-like, oblong, strongly acuminate scales, simulating the leaves of mosses (fig. 11). The foundation is, however, in every case an organized cell, the red colour of whose daughter-cells is precisely that of the oidioid thread of the black fungus. Whatever may be thought of the second and third forms of vegetable growth, this, at least, must be considered as identical with the first, though at present the Chionyphe has not been raised from its globules, which, however, are so closely involved in stearine, that their germination is scarcely probable.

Dr. H. V. Carter has in his second memoir entered at some length into the probable mode of introduction of the evil, but as his observations depend mainly on the erroneous reference by Corda of the genus Æcidium to the group of Myxogastrous fungi, the spores of which in germinating frequently put on the characters of such infusoria as amœba, and whose subgelatinous spawn consists of a substance analogous to, if not identical with, the sarcode of Dujardin, it is not necessary to follow him on this

point. There is not the slightest ground for supposing that the disease depends on inoculation with the spores of any of the truly parasitic fungi belonging to the tribe of rusts and mildews, and, therefore, more or less closely allied to Æcidium; but great reason, on the contrary, as appears from what has been stated above, and in the Appendix B to the second memoir, for looking to the origin amongst the mucors, even were there not something like direct proof.

It is well known that mucedinous fungi make their appearance within cavities of vegetables which have no apparent connection with the outward air. Nothing, for example, is more common than to find a pink mould (*Trichothecium roseum*) in the middle of a nut; and an allied vegetable production (*Dactylium*



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oögenum) has been found in an unbroken egg. Even the cells of plants themselves produce fungi which fructify within them. How the spores are carried there is at present a mystery, which may some day be cleared up, like the origin of many intestinal worms, which can no longer be brought forward as an argument for equivocal generation. There is, however, reason to believe that amœboid growths are not confined to such dust-like fungi as the Æthalium which is such a pest in pine-stoves; and zoospores have already been ascertained to occur in certain moulds, as, for example, in the Peronospora which causes the potato murrain. The Fungus foot is confined to the natives who go about with naked feet, and the spores might easily be

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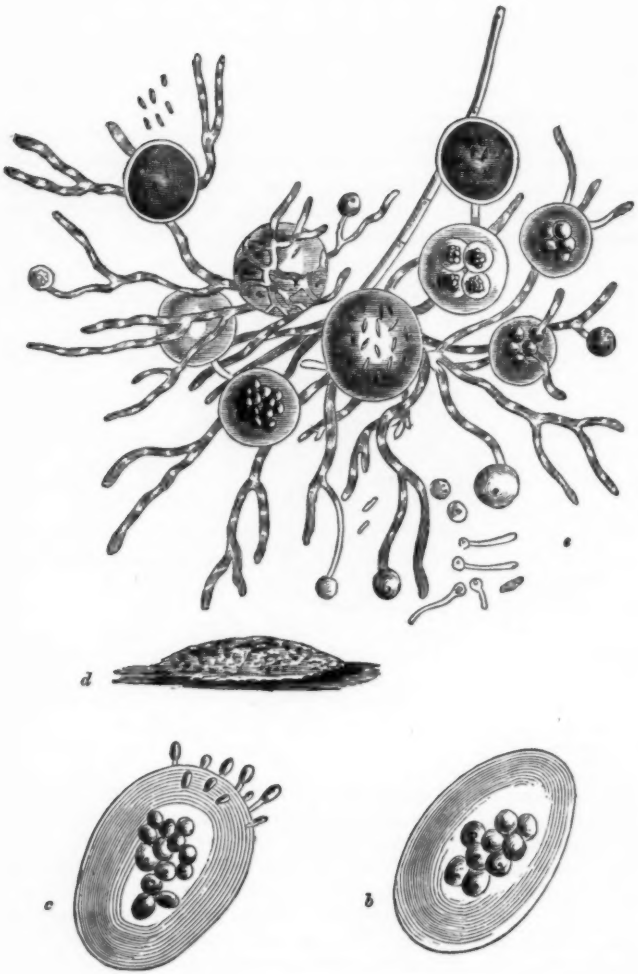
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introduced through some scratch, even were it impossible for them to penetrate by the pores of the skin. When once introduced beneath the cuticle a single spore might soon perform the work of destruction spreading in every direction, and according to the peculiar condition of the secretions, the mycelium might put on a hundred different modes of growth. Besides, if the fungus is capable of causing the absorption of solid structures like bone, it is easy to conceive that a spore in contact for some time with a moist foot might penetrate the cuticle simply by absorption. Cleanliness in the first instance seems to be a preventive, but when the fungus is once established, there seems to be no cure save amputation—which, happily, when resorted to in time appears to be completely successful, as the disease never spreads beyond a certain point, though, if it be allowed to take its course, death will ensue from the exhaustion consequent on pain and the continuous discharge.

In some cases it would seem as if the foot was already in a diseased state when the fungus was introduced. At least the history of one case which apparently commenced with a boil on the instep, which was treated by native doctors, a thorn being used several times as a lancet, indicates such a lesion as might well encourage the growth of a fatal parasite.

EXPLANATION OF THE PLATE, p. 256.—*b* a single cell magnified which has been freed from the coat of stearine by immersion in pure sulphuric ether; *c* a budding cell similarly treated; *d* the red fungus, *Chionyphe Carteri*, springing from particles of the black fungus scattered over rice paste; *e* a portion of the same magnified, showing the sporangia in different stages of growth, from their first origin to the dispersion of the spores, and some of the latter germinating.

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ON THE AURORA BOREALIS.

BY DAVID WALKER, M.D., F.L.S.

An appearance so remarkable as the Aurora could not fail to attract the attention of early observers, and afford cause for much conjecture.

About the earliest theory respecting its origin, supposed that it was produced by the refraction of the sun's rays; another, that it depended on a mixture of the atmosphere of the sun and earth; while many ascribed it to the effects of the magnetic fluid. But as the science of electricity became better known and more fully developed, when its luminous effects were shown, and especially when a resemblance was traced between the luminosity displayed by the passage of an electric current through a partially exhausted tube, and the appearance of Aurora, all previous hypotheses were abandoned, and the theory of Cavendish pretty generally adopted, which supposed that Aurora is dependant on electricity, transmitted through regions where our atmosphere is in a very rarefied state; at the same time it considered that some connection could be traced with the magnetic force of the earth. Since the laws of meteorology have been more fully understood, and the practice of recording meteorological observations more widely extended, the appearance of Aurora has attracted proportionate attention, especially in its connection with the local variations of the magnetic needle, and the disturbances noticed in the atmospheric electrometers. Such observations have shown, among other facts, that an Auroral light has been simultaneously perceived over a very extended space, *e. g.* the Auroral light and magnetic disturbances of 1831, 1839, and 1859, were noticed at the same time, not only in the northern hemisphere, but also in the southern. Tables of the comparative frequency of the appearance of Aurora in different places, however, indicate the neighbourhood of the Arctic zone as that in which these phenomena most frequently occur.

Electricians and astronomers have endeavoured to ascertain the height of the Aurora above the earth by measurement of its arc, but the results of their observations, taken from different points of view, and perchance not directed to the same Aurora —each observer seeing his own particular arc—are discordant. Thus, of two observers who calculated the height of an Aurora in January 1831, one made it eighteen miles, the other ninety-six. The ancients believed it to be very great, even beyond the limits of our atmosphere. Cavendish supposes its *usual* elevation to be about seventy-one miles above the earth, at

which height the atmosphere must possess but $\frac{1}{150000}$ part of the density of that at the earth's surface. More modern observers think it seldom rises above the region of the clouds, while Parry, Wrangel, Struve, Fisher, Farquharson, and others, ascribe to it a very inconsiderable height.

Observations made in Aberdeenshire tend to prove that at times it is not more than half a mile above the surface of the earth. Parry, in January 1825, whilst watching the variations in the forms of an Aurora, saw a ray of light dart down from it towards the earth, between himself and the land, which was some 3000 yards from him, two other officers of the expedition witnessing it at the same time. I believe I am correct in stating that many Arctic observers believe the Aurora to attain a very small elevation in high latitudes. Hood and Richardson observed the same Aurora from different places; to the one it appeared in the zenith, forming a confused mass of flashes and beams; to the other, many miles distant, looking in the same direction as the first observer, it presented the aspect of a low illumined arch. Sir William Hooker informs me that, while passing a night on the summit of Ben Nevis, he distinctly saw the Aurora hang in the valley between a neighbouring elevation and that upon which he stood; also, that at another time, during a fall of snow upon a mountain side, he observed the particles to be distinctly luminous, the air giving evidence at the same time of the presence of much free electricity. General Sabine tells me that he has seen the Aurora low down, and passed through it, as one would walk through a mist. On the nights of the 30th and 31st March, 1859, I noticed the Aurora between myself and the land. The patches of light could plainly be seen a few feet above the surface of the water in Bellot Straits, the opposite land being about two and a half miles distant; and I am confident that had the land been sufficiently high, many of the Auroras seen during the winter above the water space in Bellot Straits would have been seen suspended above the water or ice at a low elevation.

I give an abstract of over two years' continuous observations in the Arctic regions. More than half the number of Auroras noticed were seen in the direction of an open water space, where much evaporation was going on; these Auroras beginning to appear at various degrees above the horizon, over a fog bank. Many were observed when minute spiculæ of snow were visible in the atmosphere, or when a mist gradually filled the air, also when cirrous clouds were seen, even when their presence could only be detected—on account of their thinness—by the formation of a halo round the moon. Occasionally, when daylight appeared, and the Aurora became gradually invisible, in its place thin fleecy clouds were noticed.

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Several of the Auroras affected *the electrometer* and the magnetic needle, causing in the former marked and increased divergence of the gold leaves, and considerable oscillation and variation in the movements of the latter. I will copy from my journal the notice of one Auroral exhibition:—"Dec. 17th, 1857, at 6·30 P.M., observed a faint Aurora from S.S.E. to E; nothing particular in its appearance, it died out about 7·15. At 10 P.M. observed a bright Aurora extending from S. to N.N.E.; a low bank of fog, 5° above the horizon, formed the edge of an arc about 1° broad; 2° above this another arc was situated, about 4° broad; these changed into broad luminous clouds at times, and then again formed one thin long arc, extending continuously from S. to N.N.E., with streamers ascending 8° to 10° towards the zenith; the colour generally a yellowish-green, but once it was quite reddish in the E., at which point the Aurora was most intense and constant. I again noticed the pulse wave; it oscillated from S.S.E. to E.; the 'merry dancers' sometimes was the form assumed; once or twice there was an instantaneous intensity in the light of the whole mass, and as quick a relapse to the original.

"In the thick body of the Aurora the light was so intense as completely to hide the appearance of stars of the first magnitude,—through the streamers the stars showing, although but dimly. At 11 o'clock, I noticed a shooting star of a very bright character; it descended from 35° degrees above the horizon, and below Saturn towards the horizon, but on approaching the Aurora it was dimmed and then completely obscured; it fell very slowly, when it came to the thick band it left a tail 2° behind it. No sounds were heard with the Aurora; those bands which did appear were as luminous as those of last night, but were more confined to one part of the sky. 12 P.M.: still continues, more concentrated and a little brighter; dense streamers longer and altogether higher above the horizon. Since the appearance of the Aurora, the wind has increased. Temperature —21°. 4 A.M.: the Aurora still brilliant and in the same direction, forming more of an acriform shape, and changing sometimes to a reddish hue. 9 A.M.: still apparent, now crosses the zenith, not in streamers but in shapeless patches of thin light, from S.W. across the zenith to W. and W.S.W.; also from E. to N.W. a broad band, about 70° above the horizon in E., is very persistent against the blue background; the stars are visible through it. *Minute spiculæ of snow visible through the atmosphere.* As the daylight increased the Aurora became less visible, and at 10 A.M. it was not seen, but in its place thin fleecy clouds appeared, just as if it had been the cloud which had been rendered luminous. At 10·30 A.M., whilst the cloud still remained, I connected an electrometer with the copper

wire in the observatory, when distinct separation of the gold leaves took place. At 6 P.M. an Aurora was visible from E. to W. and N.W. across the zenith; it was in the form of bands or streamers. I again tried the electrometer, and again perceived distinct divergence of the gold leaves. This Aurora disappeared about 7 P.M. Again, at 8·30, there was an Aurora, stretching from S.S.W. to S.S.E., in the form of a bent arch or horseshoe, the key being in S.S.E. Again the electrometer was connected, and a still greater divergence of the gold leaves than before was noticed. This may be from the greater luminosity of the Aurora. I tried paper saturated with iodide of potassium, interposed between two platinum wires, connected with the chain and the water, but no decomposition took place and no spot was obtained. 12 P.M.: this Aurora is still visible, but with no particular shape; it extends from S.S.W. by S. to N., and not only horizontally but vertically scintillations appear. It is most luminous towards the S. where occasionally a wave appears, not like a pulse, as was the case the last two nights, but as if the cloudy appearance had been connected in the S.S.E. with an electric machine which, when turned, caused a flash of light to proceed from S.S.E. to S. Thin streamers passing towards the zenith; the body of the light decidedly obscures the stars of all magnitude behind it. Temperature —23°·5, bar. 29° 82."

So much for my own observations. Before, however, deducing thence any theory, I will condense a few of the latest and most plausible. M. Biot's is in substance as follows:— That the luminous clouds of which the Aurora consists are composed of metallic particles, reduced to an extremely minute and subtle form. Such metallic clouds—if the expression may be permitted—will be conductors of electricity, more or less perfect, according to the greater or less proximity of their constituent particles. When such clouds arrange themselves in columnar forms, and connect strata of the atmosphere at different elevations; if such strata be unequally charged with electricity, the electrical equilibrium will be re-established through the intervention of the metallic columns, and light and sound will be evolved in proportion to the imperfect conductibility of the metallic clouds, arising from the extremely rarefied state of the fine dust or vapour of which they are composed. If the metallic cloud possess the conducting power in a high degree, the electric current may pass through it without the evolution of light or sound; and thus the magnetic needle may be affected as it would be by an Aurora, though none be visible. If any cause alter the conductibility of those columnar clouds, suddenly or gradually, a sudden or gradual change would follow in the splendour of the Aurora.

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M. Becquerel objects to this theory that the existence of metal, in that uncombined form in which alone it has the conducting power—in volcanic eruptions—is not yet proved. In explanation of which objection, it should be added that M. Biot's theory supposed the electricity to proceed from polar volcanoes.

Professor Faraday, in vol i. of his *Researches*, remarks:—"I hardly dare venture, even in the most hypothetical form, to ask whether the Aurora Borealis and Australis may not be the discharge of electricity thus urged towards the poles of the earth, from whence it is endeavouring to return by natural and appointed means above the earth to equatorial regions."

Humboldt says:—"The Aurora Borealis has not been described merely as an external cause of a disturbance in the equilibrium of the distribution of terrestrial magnetism, but rather as an increased manifestation of telluric activity, amounting even to a luminous phenomenon, exhibited on the one hand by the restless oscillation of the needle, and on the other, by the polar luminosity of the heavens. The polar light appears, in accordance with this view, to be a kind of silent discharge or shock, at the termination of a magnetic storm, the disturbed equilibrium of the electricity is renewed by a development of light by lightning, accompanied by pealing thunder."

M. De La Rive, after speaking of the two electricities of the earth and atmosphere, and the recomposition going on between them, and stating that the great electrical discharge takes place at the poles, proceeds:—"This discharge, when it has a certain degree of intensity, will be luminous, especially if, as is nearly always the case near the poles, and in the higher regions of the atmosphere, it meet on its way those extremely attenuated frozen particles out of which the loftier clouds and mists are formed." More lately still he expresses similar and more elaborate views. (See abstract in the INTELLECTUAL OBSERVER for August.)

In the Arctic seas there is always more or less evaporation from the surface of the exposed water, and according to the time of year the area of exposed sea surface will be great or small. Towards the end of August and beginning of September, as the sun's altitude decreases, the nights become gradually colder, the surface of the sea is frozen over, and the difference between the temperature of the air and water increases. [For my purpose I will speak of the sea of Baffin's Bay and Davis's Strait.] With the advance of the season, the evaporation, which in summer appears as fog, in winter takes a different form; for wherever a space of water appears, and the temperature of the air is colder than that of the water, the vapour of the water, in rising from its surface, becomes visible as a dense

mist over that place, and is termed "frost smoke," or "water blink." The mass of ice filling Davis's Strait and Baffin's Bay is broken up by winds, tides, and currents, and spaces of water appear among the fields of ice; throughout the winter the air in the neighbourhood of these spaces is always loaded with extremely minute spiculæ of snow, recognizable as "frost smoke." As the cold increases, the number and intensity of Auroras, seen at any place on the Greenland coast, would be in proportion to the proximity of the edge of the ice to that place, for, as a rule, Auroras increase in brilliancy as they approach the zone of the line of winter ice. If we draw a meridian line passing through the middle of North America, we find the annual number of Auroras increase up to 62° N., where they appear in all parts of the heavens; farther north the number decreases, and the display is seen more frequently in a southerly direction. The same rule will hold good of a meridian passing up Davis's Strait, only the maximum point of auroral intensity will be situated several degrees to the *northward* of 62°. Still more so will be the comparison for a meridian passing through Central Europe. Early in the winter, at the northern posts of Greenland, the Aurora is seen indefinitely higher up in the sky, and nearer the zenith, than at a later period of the year, when, after the sea has been, to a great extent, covered over with ice, the Aurora locates itself towards the open water spaces. During the first fifteen months of Dr. Kane's stay at Rensselaer Harbour, no Auroras were seen, or open water space noticed. At the south of Greenland, where the ice of Davis's Strait edges upon the waters of the Atlantic, a greater number of Auroras is seen than in any other place along that coast line. Most of the Auroras noticed during the last Arctic expedition were in the direction of the open space of water seen during the day, such spaces being, as usual, marked by the "frost smoke."

From the above well-authenticated facts, I cannot but believe that these Auroras were connected with the vapour arising from the open water spaces, and that they were caused by the condensation and subsequent freezing of the particles of vapour; such particles evolving positive electricity, and by induction from the surrounding atmosphere producing a light transmitted from particle to particle, thus rendering the whole mass of vapour luminous, the lower edges of the arch of the Aurora being the place where first this condensation and freezing takes place. And if such be the cause of many of the Auroras near the Arctic circle, I see no reason why the same effect should not be produced elsewhere under similar circumstances.

Whenever the temperature of a cloud, charged with particles of vapour, is lowered—either by changing its position, or by the access of a colder atmosphere—and the particles become

frozen, then electricity will be evolved, and by induction a luminosity will appear; such clouds meeting with others of opposite electricity, would communicate by means of streamers, these also being luminous. In other words, a vaporous cloud, passing through a region where the air is of lower temperature, becomes condensed, and, if the temperature be sufficiently low, composed of minute frozen spiculæ, which induce recomposition between other clouds of different electricity near them, causing streamers and bands to flash out light. These appearances will present themselves wherever there are clouds composed of frozen particles, acted upon by the surrounding atmosphere or by neighbouring clouds, so that no altitude will be too great or too inconsiderable for the appearance of Aurora so long as the atmosphere contains the necessary conditions for the evolution of this light. Oftentimes in this country, and in crossing the Atlantic, I have seen Auroras which at times assumed simply the appearance of cirrous clouds. The wind may occasion a pulsation in the body of an Aurora, and even a greater degree of brilliancy, the friction produced by it perhaps causing an increase in the electricity evolved.

I believe Aurora is never seen, except when clouds or other similar vapours are exposed to the process of congelation. We know by Mr. Glaisher's last balloon ascent that a temperature of —20° occurs at a height of six miles above the earth, at the same height clouds exist; here, then, according to this "congelation" theory, Auroras may appear, or at any other heights where similar circumstances are to be found. It may be argued that Auroras are often seen on a clear night when no clouds are visible, but there is *no proof* that vapour-masses do not exist at the same time; in fact, often when no such masses are seen in the sky, a halo round the moon or sun will exhibit irrefragable evidence that such are present, though they be otherwise undistinguishable.

This theory would go far to account for the more frequent appearance of Aurora in this country lately, the amount of cold having been greater during late winters: last winter, however, being mild, very few Auroral displays were noticed.

PLUCKER ON SPECTRUM ANALYSIS.

THE following is a translation of two articles which have appeared in *Cosmos*, from the pen of the celebrated philosopher of Bonn, and will be regarded as a very valuable contribution to our knowledge of a new and interesting subject. It tends, on the one hand, to correct exaggerated notions of the facility which the new process affords of ascertaining the constitution of the sun, or other remote bodies, while, on the other, it opens a wide field for further research and discovery. M. Plucker observes:—"Spectral analysis, as conceived by me in 1858—9, consists in introducing the gas to be examined in tubes, of which one portion is capillary. After having conveniently rarefied the gas by means of a mercurial evacuator, the discharge of an induction apparatus is made to pass through it. The electric current, condensing itself in the capillary tube, renders incandescent the gas which it contains. The light is sufficiently bright to afford a beautiful spectrum, which is usually composed of a certain number of brilliant and characteristic lines, one of which, whose position is exactly determined, indicates the nature of the gas which is the subject of the experiment.

"I have thus operated on the ordinary gases and on certain vapours. When the vapour of a substance introduced into the tube has not the density necessary to cause the current to pass through it, a lamp is employed to increase the vaporization until the current traverses it, and produces incandescence. In this way I have treated mercury. Following the same principle, to obtain the spectrum of metallic sodium, I first fill the tube (which I have named after Geissler, the ingenious artist by whom it was constructed) with a neutral gas, hydrogen, whose spectrum is known.

"The spectra of different bodies in a gaseous state may be divided in several classes, each exhibiting peculiar characteristics, and the following considerations arise from the varied appearances they present. If the light received by the spectroscope contains all the colours whose refrangibility increases from the red to the extreme violet, the continuous spectrum that is obtained is composed of an infinite number of superimposed bands, of which each has the breadth of the slit as seen through the telescope. The Drummond light offers an example of this kind. If, on the contrary, the incident light only contains a limited number of colours, the spectrum is discontinuous, the luminous bands being separated by black spaces. These bands tend to become mere lines if the aperture of the slit is reduced. Hydrogen gas and chlorine, together with the

vapours of iodine and bromine, offer examples under the conditions described in my memoir.

"If the index of refraction of two successive colours differs very little, the two corresponding bands are partially superimposed the one over the other, and then, if a good telescope is used, the middle of the composite band exhibits a double intensity, sharply bounded by two bands, the breadth of which is equal to half that of the slit. As the slit is narrowed more and more, the most luminous central portion diminishes in breadth, and disappears entirely when the breadth of the direct image of the slit is less than the distance of the median lines. The two simple bands are then separated by a dark space. The distance of lines in the midst of the two bands* is independent of the width of the slit. The beautiful double ray of mercury affords an illustration.

"If the incident ray contains a continuous series of colours, the intensity of which decreases rapidly as their refrangibility increases, while the colours immediately inferior in refrangibility are wanting, the corresponding portion of the spectrum presents a space which is very luminous towards the red side, and becomes more and more obscure towards the violet. If similar spaces succeed each other, the appearance is presented of a column grooved and illuminated by daylight. The blue and violet portions of the spectrum of nitrogen, when seen through a good telescope, behave in this way. Analogous results occur in the case of spaces whose illumination diminishes from the violet to the red, of which I will hereafter cite an example. If the incident light contains, within certain limits, continuous colours, with the exception of periodical interruptions, the spectrum obtained is divided by double lines into a series of coloured spaces. I have counted in the red, orange, and yellow portion of the nitrogen spectrum eighteen coloured spaces, all of the same breadth. If the spectrum is fine, we observe two of these spaces added to the shadow next the yellow, and three in the green that follows it. The spectrum of sulphur, which M. Geissler was the first to obtain, is entirely composed of similar coloured spaces, the breadth of which is augmented from the red to the opposite side.

"If we admit that the active force developed by the heat that renders the gas incandescent is of the same order in the case of a continuous spectrum, as in a spectrum composed of one or many bands of homogeneous light, we must conclude that the intensity of these bands is infinitely greater than that of light of equal refrangibility in the continuous spectrum. It follows, on one hand, that we must reject all idea of absorption to explain the appearance of similar bands in the place of a continuous

* "Milieu des deux bandes."

spectrum; on the other hand, it results that if we employ considerable magnifications, and augment the refraction, the bands in question will remain distinctly portrayed, while the continuous spectrum and the coloured spaces become almost imperceptible. Thus, when employing the telescope of the great spectroscope apparatus of Steinheil, I immediately perceived that the bands of the homogeneous light which I admitted into the violet part of the nitrogen spectrum only existed under the conditions cited, while, in the case of hydrogen, I was able to confirm the existence, in the obscure part of the spectrum, of homogeneous bands of very feeble intensity.

"When, for the sake of giving a more elevated temperature to a rarefied gas, I caused the current occupying a larger space to pass through the capillary tube, I have observed, from the commencement of my researches, a change of colour accompanying the change of intensity. In other words, the relative luminous intensity of the different homogeneous lines which usually constitute the spectra of gases, is seen to be a function of temperature. I subsequently showed that in the case of hydrogen, the intensity of the three lines forming the essential part of its spectrum, do not diminish in equal proportion, and that the red line is extinguished first as we approach through the rarefaction of the gas to the point beyond which it cannot transmit the electric current. Latterly many experiments appeared to contradict my former observations, and this led me to fresh exertions, especially with a view to carry the elevation of temperature to a greater pitch than I had hitherto done.

"If we employ spectrum tubes in which the gas is extremely rarefied, little is gained in the way of increasing the luminosity of the spectrum by pushing, beyond a certain limit, the power of the induction coil, whose discharge traverses the tube; but by operating in the manner indicated in a former memoir, a new course is opened to us. M. Hittorf, Professor of Chemistry and Physics in the University of Munster, was kind enough to associate himself with my recent labours; and in confining myself at this moment to one class of phenomena, I shall select from our experiments those which illustrate the transformations experienced by the spectrum of the same gas, as its temperature is augmented more and more by the passage of currents of increased strength. In the first place I will allude to the spectrum of hydrogen. If we pass the discharge of a large Ruhmkorff coil through a capillary tube, very narrow and not long, filled with this gas at a pressure of about half an atmosphere, a spectrum is obtained similar to that afforded by employing a small coil and a great rarefaction of gas; but if we interpose, as suggested by M. Ruhmkorff, a Leyden jar, to increase the energy of the current, the spectrum completely changes its

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appearance. It becomes continuous; the violet and blue lines no longer arise from the ground, which has become lustrous, and we notice at one extremity of the spectrum the red line become broader, and surpassing in brilliancy the adjacent parts. Lastly, if we direct the spectroscope towards the broad part of the tube surrounding the electrode, where the light, before entering the capillary tube is less concentrated, an intermediate phenomenon is presented to our view. We still see the three primitive lines, but while the red one remains pretty much as before; the two others appear in bloom, the violet more than the blue.

"Nitrogen gas behaves in a manner altogether different; the beautiful spectrum of this gas, as I at first obtained it by means of the small induction apparatus, remains essentially the same when the great apparatus is used without the bottle and its tension is augmented to about 100 millimètres. When, however, we introduce the Leyden jar, all is changed; the new spectrum contains no trace of the old one: it is composed of a great number of beautiful lines of refrangibility one (partially separated by fine black lines), and not one of them is like the former spectrum. Sulphur and selenium afford analogous results. The spectrum of oxygen is weak under the old conditions, but if the tension of the gas is about 100 millimètres it gives with the great induction coil, and the Leyden jar, a spectrum of great beauty, composed of lines of refrangibility one. The greater intensity of the current brings out a great number of new lines. The same thing happens with chlorine and iodine.

"The former spectrum of the vapour of mercury was essentially composed of three brilliant lines, of which one is double. In the new one, other lines are added, especially red lines, and a double orange line, which at first were not even indicated; and at the same time the feeble lines on the ground of the first spectrum are less developed, as is the case with hydrogen. In this same spectrum of mercury, the green and orange rays, sharply bounded when the temperature is weak, dilate themselves more and more towards the red as the heat is increased."

Having thus illustrated the physical appearance of the spectra, M. Plucker makes the following remarks on their employment in chemical analysis:—"It seems that no compound body in a gaseous state can escape decomposition if we augment its temperature sufficiently. To effect this result, we introduce the gaseous body into a Geissler tube, then we heat the minute thread of gas in its capillary portion by means of an induction current. We then examine the incandescent thread of gas with a prism. In my former spectrum tubes a feeble current sufficed to obtain the spectrum of highly rarefied gas, but in this case the decomposition, if it occurs, is often partial. Two

of these tubes—one containing carbonic acid, and the other carbonic oxide—give the same spectrum, namely, that of the last gas, which is not essentially changed by augmenting the force of the induction coil: as beyond a certain limit the temperature of the gas is not increased. In the new tubes, containing gas of a greater density, a stronger coil is required than in the old tubes, to bring the gas to a given heat; but the gas assumes a much higher temperature as we increase the power of the coil. Thus, in two recent experiments we gave to the two gases a pressure of 100 millimètres, and illuminated them with discharges of a great Ruhmkorff coil. In discharging the apparatus in an ordinary way we obtained the ordinary spectrum, that of the carbonic oxide; but upon interposing a Leyden jar of convenient dimensions, we instantly descried the beautiful spectrum of oxygen, identical with that obtained when the tubes were filled with pure oxygen at the same pressure, and transmitted a current of electricity in the same way. . . . I therefore conclude, that at a lower temperature the carbonic acid is resolved into carbon and carbonic oxide, and at a higher one this latter gas is itself decomposed, whether we introduce it in the first instance into the tube, or obtain it by the action of the current upon carbonic acid. This is not all, for immediately after the decomposition the temperature falls, and the recomposition of oxygen and carbon ensues.

"In citing these examples of the decomposition of bodies, as evidenced by spectral analysis, the decomposition of the vapour of water must not be passed over. We introduce water into the interior of the new tubes, and, before sealing them in a lamp, we boil the water to expel the air. If we then make the electric current pass, without the Leyden jar, we obtain only the three rays of hydrogen on a dark ground. With the addition of the Leyden jar we get the oxygen spectrum also, clearly defined. This experiment illustrates the facility with which the current traverses hydrogen gas. If a rarefied gas contains the least trace of water, the water is decomposed, and the hydrogen rays, especially the red and blue, are exhibited in the clearest manner. If, for example, we cause the electric discharge to pass through a tube containing nitrogen which has been dried, but without extreme care, and we establish a communication with a mercurial evacuator, we see first, as we produce a vacuum, the beautiful spectrum of nitrogen, which is replaced by that of hydrogen as the limit of rarefaction is approached. As a third illustration, I shall take chloride of zinc. After having introduced a small quantity into the spectrum tube, the vacuum is made as complete as possible. We then obtain, on heating the tube, first the chlorine spectrum, slightly developed, but easily recognizable; afterwards continuing to heat the gas, this spectrum, which at

first augments in intensity, gradually disappears and that of metallic zinc comes into view. At last we see only the spectrum of this metal, which is essentially composed of four lines eminently brilliant and sharply defined; one being red, more refrangible than the red ray of hydrogen, and the three others occurring in the regions of green and blue. If the tube is permitted to cool, we notice the phenomena in inverse order, the zinc spectrum disappearing first and being replaced by that of chlorine. Excepting the non-coincidence of its bright rays, chloride of cadmium comports itself like chloride of zinc.

"Mr. Miller has lately presented to the Royal Society of London very remarkable photographs of the brilliant bands of the spectra of all the metals, but they do not seem to be as sharply defined as ours. The difference may probably be explained by the greater elevation of temperature of which his were produced. I conclude, from the facts previously cited, that these spectra were 'en marche' towards the continuous spectrum.

"If we can employ a sufficiently powerful induction coil, we may produce the spectral effects with gases having a pressure of one atmosphere or more. We might even pass a continued current of gas through the capillary tube instead of closing it hermetically. A glass tube open at both ends and having an inch or so rendered capillary in the middle, with platina wires thrust up as far as the capillary portion, becomes a veritable chemical analyser. We place one of its extremities in communication with the apparatus in which the gas to be examined is developed, or with the neck of a retort yielding any vapour, and the fluid gas or vapour becomes incandescent as it passes the capillary portion of the tube, where the platina wires are connected with an induction coil. If we wish to operate at ordinary pressures we let the gas escape freely at the other end of the analyser, and if we desire a lesser pressure it is easily obtained. The essential character of the analysis thus briefly sketched is that it not only enables us to recognize particular substances that may enter into the composition of a given body, but to exhibit all its elements. To do this in a sure and complete manner it is necessary to ascertain for each body the changes which its spectrum undergoes at each successive elevation of temperature. We must also take account of the greater or less facility which different substances offer for the transmission of the current, and likewise not forget the transport of the substance of the electrodes.

"Up to the present M. Hittorf and myself have only touched the borders of the chemical question, and of other questions related to it, but the sphere of application of the new mode of analysis appears to us great."

RESTING EGGS, OR STATOBLASTS OF A PLUMATELLA.

BY HENRY J. SLACK, F.G.S.

(*With an Illustration.*)

On the 29th June, 1861, the day being fine and hot, my attention was called to an entangled mass floating in the large pond at the bottom of Hampstead Heath, behind Jack Straw's Castle. On drawing a portion of it ashore by means of a landing hook, it was evident that the capture consisted of fresh water polyzoa. The cœnœcium (common house) or polypary was very compact, and composed of numerous tubes, having a multiplicity of openings; but none of the branches projected far from the main stem, which clung to, and surrounded the long fine stalks of some defunct water plant. This mode of growth was more like that of certain marine forms of polyzoa than of any which I had been in the habit of finding in ponds or streams; and as the pocket lens could only afford general evidence of relation to the Plumatella family, I hastened home to call the microscope to my aid. A branching tuft of the polyp tubes was soon placed in a zoophyte trough, illuminated by Wenham's parabola, and viewed under a two-thirds objective. The effect was splendid. The living flowers expanded freely, the tentacles assumed a pearly lustre, and the vibrating cilia glowed like scintillating jewels as they caught the light. It was evident that the *lophophore* or "crest-bearer," from which the tentacles proceeded, was crescent-shaped, or, as it is technically termed, *crescentic*, and not circular; and the tubes, taken separately, bore a strong resemblance to those of *Plumatella repens;* but I had never seen or read of this species forming a colony in such a dense enveloping mass. Of course, a reference to Professor Allman's splendid work on the Polyzoa was my first resource, but not finding the difficulty solved, I bottled up a good specimen, and sent it by post to that able naturalist's address. Unfortunately, the creatures did not reach him alive, and this circumstance, together with a pressure of other engagements, prevented his settling the point, whether they could be identified or not, with any recorded species. My own impression was in favour of considering them as varieties of P. repens, as the tubes had neither furrow nor keel, and I noticed no characters that assimilated them more closely to any other member of the Plumatella family.

I gave my specimens abundance of water in a large glass jar, in which some anacharis and myriophyllum were growing, and left them in an airy room, where I hoped they

would flourish. My house was at the time in a state of siege, assailed by bricklayers, carpenters, painters, plumbers, and other enemies of scientific work, and from this cause my polyzoan visitors did not receive the attention they deserved. After a week or two I returned to their examination, and found to my vexation that the whole colony had departed this mortal life. Their houses also were in a very dilapidated condition, quite unfit for preservation, and I could only console myself by noticing that the good polypides had made abundant provision for the perpetuation of their race, by leaving behind them thousands of *statoblasts*, or resting eggs.

The generation of these creatures takes place in three modes. First, by the eggs developed in an ovary, attached by a short stem or peduncle to the *endocyst*, or internal and vital membrane of the cells. The male organs, which fertilize the eggs, occur in the same cells as the ovaries, and are connected with the *funiculus*, literally, "little rope," the name given to the flexible band by which the body of each polypide is moored to the bottom of its cell. The second mode of increase is by the growth of fresh cells, as off-shoots from the colony; and the third is by the production of *statoblasts*, which are probably only *caducous** buds, that is, buds destined to fall off at a certain time, and wait for their development until appropriate circumstances arise. Professor Allman could not detect any mode by which these statoblasts could be expelled during the life of the particular polypide in whose cell they are formed, but after the death of the animal, decomposition clears their way, and they find no difficulty in falling out. As a rule, they are objects of considerable beauty, more or less oval in form, and surrounded by a marginal ring of a different colour, and in which the cell structure makes a pretty pattern of the network kind. In Cristatella mucedi, remarkable for the locomotive properties of the entire colony, the statoblasts are round, and still further decorated with projecting spines. In the specimens under our notice, these objects were like those produced by undoubted *Plumatella repens*, and I was curious to see whether any of them would develop, and reproduce, or omit, the peculiarities of the maternal form. For this purpose hundreds, or thousands of them were placed in a glass jar full of water, and having a few bits of anacharis for their vegetable companions. The summer ended, the autumn came, the autumn passed, but no appearance of activity was manifested by the little egg-buds, which either floated on the surface of the water, or adhered to the sides of the vessel. Occasionally I squeezed one between the glasses of a live box, and from the appearance of the contents, conjectured

* Caducous (*caducus*, ready to fall), see Henslow's *Dictionary of Botanical Terms*.

that they were in good health, although persisting in their inexplicable rest. The cold of winter was not likely to summon their dormant powers to exertion, so they were allowed to repose on a shady shelf, the glass jar being lightly covered over to exclude the dust. By spring time the anacharis had died, and the water was reduced to half its bulk by evaporation, leaving many of the statoblasts high and dry on the glass. Fresh water was poured in, and the vessel removed to a lighter place.

On the 18th of May a few of the statoblasts were discovered gaping, the shell having opened like that of a walnut. A group were speedily transferred to a zoophyte cell, and placed on the microscope stage; one polypide appeared just out—just hatched, I would say, but we must remember that we have to do with a peculiar kind of bud rather than with a genuine egg; the tentacles of the new-born polypide were beautifully expanded, but for an hour or two it was impossible to discern the crescentic form, and it might easily have been taken for a Fredericella, whose tentacles are arranged in a beautiful bell-shaped pattern, like those of the common sea-side members of this most interesting group. As far as I could make out, the circular aspect arose from a close approximation of the two arms of the crest-bearer, or lophophore, and the inconspicuous position taken by the tentacles on its inner side. In another specimen the exit from the shell went on under our eye, and the sketch which my wife made, and which forms a tinted plate, gives a good idea of how the infant polyzoon looked.

The glass jar containing the main stock of statoblasts stood in my study window, which has a north aspect, so, for the sake of varying the circumstances, I placed a few dozen in a bottle, and exposed them to as much sun as a dismal summer afforded, on a southern greenhouse shelf, keeping off the extreme glare by a thin paper screen. In this position three or four developed themselves, but the greater warmth did not exert as much influence as might have been supposed. The few specimens I obtained were used up in microscopic examinations, and a pause ensued, which was not broken till the 22nd of August, when I noticed a few more young polypides in the glass jar; those in the bottle remained as before. Since that date I doubt whether any progress has taken place, and as I did not succeed in keeping any specimen long enough to form a series of new cells and branches, I cannot tell whether they would have reproduced the compact entangled form or "gone back," as the florists say, to the simpler pattern in which the P. repens is usually found.

Probably in a good sized fresh-water aquarium in which the natural conditions of a pond would have been more accurately

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imitated than in my jar and bottle, the fate of the statoblasts might have been different. More might have developed, and those that emerged from their curious resting-house might have lived the full term of their race, and resembled the fruitful vine in the number of branches they would have put forth.

As some readers may not be familiar with the characteristics of the polyzoa, a few words on that subject may not be out of place. In form they resemble the compound polyps, with which group they were formerly confounded, but their structure is more complex, and their zoological rank higher. The polyps have no distinct membranous stomach, but only a cavity with one orifice; they are, in fact, living bags, having, as Dr. Grant says, "a variable number of highly prehensile tubular tentacula round the mouth." The polyps belong to the sub-kingdom Cœlenterata, defined by Professor Greene in his excellent Manual* as "animals whose alimentary canal freely communicates with the somatic cavity" (*i. e.* general cavity of the body). Substance of the body made up of two foundation membranes, an outer or extoderm, and an inner or endoderm, which correspond in mode of growth with the primitive layers of the germ; no distinct neural and hæmal regions, and nervous system absent in most. Peculiar urticatory organs or thread cells usually present." The polyzoa have a distinct digestive tube with two orifices, one for entrance, and the other for exit. Their tentacles are stiffer in appearance, and not warty looking, as in the polyps, and they are furnished with two rows of cilia, the motion of which is always up one side and down the other. The intestine is bent round, so that the anus lies near the mouth, and one nervous ganglion situated near the mouth is very easily seen in many species. This ganglion acts as a rudimentary brain, and seems the source of the nerve power belonging to each individual. Recently Dr. Fitz-Müller has discovered that these creatures also possess what he terms a "colonial nervous system,"† which establishes a communication between each individual and the colony of which he forms a part.

To return to my statoblasts: I may mention that I am still keeping them to see whether any further instances of development will occur, and I should recommend any one who possesses a fresh-water aquarium to endeavour to raise colonies of these very beautiful and highly interesting animals by similar means.

* *Manual of the Sub-kingdom Cœlenterata*, by Joseph Reay Greene, B.A., Professor of Natural History, Queen's College, Cork. Longman.

† See Intellectual Observer, No. vii. p. 67, vol. ii.

PICTET ON THE METHOD OF DETERMINING THE AGE OF FOSSIL GROUPS.

M. F. J. Pictet, under the title of "Discussion de quelques points Palæontologiques," publishes, in the *Bibliothèque Universelle* of Geneva, some very important comments on a discourse delivered by Professor Agassiz, in reference to the classification of the Museum at Cambridge, United States, in which the last named philosopher observes:—

"Until now, geologists, in identifying the horizons of the successive deposits which form the crust of our globe, have started with the idea, universally admitted, that animals of the same geological age are either identical, or closely related over wide geographical extents. Nothing is further from the truth than this hypothesis, and it suffices to compare the fauna of the present period in distant continents to see how much they differ. If the remains of ancient times, belonging to the same geological periods, have, in general, appeared identical or closely related, that arises principally from the fact that they have been studied in the same geographical zones. Actually we find the same resemblance between the animals that live in the temperate zones of Europe, Asia, and North America; but when we pass to other climates the scene changes completely. It was the same in past ages, as we are taught by the tertiary mammalia in Southern Africa and in Australia, and I have no doubt this fact would be confirmed by more ancient formations as yet incompletely known. The specific differences between remains of the same age, found in deposits remote from each other, are more clearly demonstrated every day. Since I began to compare the fossils of America with those of Europe, I have been led by degrees to infer that we should probably never be able to establish the specific identity of animals that lived at great distances from each other, although they were contemporaneous. The doctrine of the identity of fossils of the same age requires great modifications. I am already certain that species of the same family, belonging to different epochs, but found in corresponding latitudes, are often more nearly related than species of the same age belonging to different zones. The time is rapidly approaching when zoological affinity alone will not be considered a sure criterion of contemporaneity; nor will the most striking zoological differences be held sufficient proof of difference of geological age. I have arrived at this result, unexpected, and perhaps painful, to geologists, by a careful comparison of numerous ancient faunas, arranged in the manner which I have already explained. If this discovery renders, on one hand, the determination of formations by means

of fossils, more difficult for those who are not familiar with zoology, it furnishes, on the other hand, the most instructive proof of the successive changes which have occurred at different periods on different parts of the surface of the globe, and it shows how, in the earlier ages, there existed, in different portions of the earth, combinations of living beings quite distinct from those which now occupy the same localities, and, at the same time, similar to those which at present exist in other quarters. In proof of this view, I now confine myself to mentioning the resemblance that exists between some extinct faunas of the Jurassic period, and the actual fauna of Australia. We can trace a similar resemblance between the extinct faunas of other periods, and the living faunas of other parts of the world. On another occasion, for example, I pointed out the resemblance between the fossil floras and faunas of Œningen and those of the temperate zone of the Atlantic states of North America."*

Upon this passage M. Pictet pronounces the following comments:—

"We are quite in accord with M. Agassiz, that an identity of faunas is not in *every case* a proof that they were contemporary, and that a difference between faunas does not always prove that they have belonged to a different geological age. But it is not sufficient for us to break up confidence in rules that have been generally admitted; we must also show in what cases safe conclusions can be reached, and what methods must be pursued. We will commence by considering the case of an identity between two faunas.

"If two indentical faunas are in each other's neighbourhood, stratigraphy has proved a thousand times that they must have been deposited in the same sea, either by showing that the beds which contain them are continuous, or by demonstrating that they occupy the same place in an analogous series. Nothing, according to us, nor according to M. Agassiz, shakes the generally admitted assertion that *identical faunas, situated in the same geographical region, are contemporaneous.*

"If identical faunas are separated by great intervals on the surface of the earth, the question alters, and it may be that identity is no proof of contemporaneity. M. Agassiz, in the citation we have made, speaks of analogous faunas found in different ages and at great distances. This singular agreement does not yet rest upon facts sufficiently ascertained, and, without wishing to contest its reality, we perceive rather a direction for the future labours of science than an acquisition already made. Such comparisons present great difficulty, for it becomes

* Not having M. Agassiz's lecture at hand, this passage is retranslated from M. Pictet's article.

a question of analogies and not of identities, and there is great scope for personal peculiarities of appreciation. M. Agassiz, for example, evidently does not intend to assert that the fauna of Œningen is *identical* with that actually living in South America; he merely wishes to say that there exists, between these two populations, more or less intimate relations, resulting from the identity of certain genera, and an analogy between a portion of the species. We do not doubt that researches undertaken under this hypothesis, would furnish new and precious documents.

"We may, however, while still considering the case of identical faunas, separated by great geographical intervals, look at another side of the question, which has not yet been touched upon by the learned Director of the Cambridge Museum, and which is not directly connected with the arrangement proposed for his collections, but which appear to us to possess great interest. If a series of identical faunas find themselves over a long space parallel to a degree of longitude, it may be that, according to our view, these resemblances are associated with a series of identical, but not contemporary climates. We will cite an illustration that has been supplied by the study of an interesting memoir of M. de Strombeck, in which this geologist shows the parallelism of the cretaceous faunas from Hanover to the middle of France, to which Algeria may be added. A series of identical cretaceous faunas succeed each other throughout this long interval, and we find them well developed in Switzerland, where they form a precious intermediary deposit. At this day Hanover and Algeria have very different faunas, and it is probable that in ancient times the climate of these two regions produced an analogous result. If we consider the two cretaceous faunas identical in Hanover and Algeria, it is probable that each lived in the two countries when they acquired a mean equal temperature, a circumstance that could not have taken place at the same epoch. We may well conceive the probability that this fauna lived in Hanover at an epoch when the earth was much more highly heated than it afterwards became, and that it always had a tendency to radiate and extend itself. In proportion as the climate changed, and the temperature became lower, the individuals that wandered towards the south could continue to exist, while those which journeyed northward would be destroyed. The centre of the fauna has thus been displaced, and by continuing this action it has successively occupied Germany, Switzerland, the basin of the Rhone, Provence, and at last Algeria, where the climate adapted to it arrived at a later time. When this fauna thus arrived at its new southern limits, its northern limits must have been also reached, and when it occupied the south of the geographical area,

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it is very probable that it was extinguished in the north, and probably in the centre. We might find many analogous examples from which we should draw the conclusion that *identical* faunas, separated by great geographical *spaces, may indicate identical climates which were not contemporaneous.* Let us only remark, that as analogous causes produce similar effects, it will ordinarily happen that in different regions the *series* of faunas will themselves be identical. The identity of faunas, insufficient to prove absolute contemporaneity, will thus serve to show that they had a similar relative age in the series to which they belong.

"If we now occupy ourselves with the case in which the faunas differ from each other, we find ourselves confronting an investigation a little more delicate and a little more difficult.

"In the case where the geographical distances between the faunas are not considerable, their difference will most often result from the circumstance that they were formed at different epochs. This is one of those facts which stratigraphy has so often put in evidence that we need not insist upon it. In a given region we frequently find different faunas superimposed in an identical order that proves their regular succession in time. But this rule is subject to important exceptions. Just as in natural seas, the association of different species follows the nature of the sea-bed, that of the waters, their depths, etc.; so, during the same geological periods, different faunas may have been deposited on muddy beds, on rocky banks, in profound depths, etc. Geologists and palæontologists have for a long time demonstrated these facts, and have given the names of 'muddy facies,' 'coralline facies,' etc., to deposits in which contemporary, but dissimilar fauna have been preserved. Every one knows the curious researches of Edward Forbes, on the different associations which the existing seas present under analogous circumstances; and, more recently, M. Alphonse Milne-Edwards has given a new extension to these facts by the discovery of species altogether new and unknown, obtained from very great depths. We may therefore say that, according to circumstances, the difference between faunas of the same geographical region may sometimes correspond with the same epoch, sometimes with a different epoch.

"It remains to be seen if, besides the stratigraphical evidence, which is alone incontestable, the palæontologist is completely disarmed when he endeavours to deal with these particular cases. We do not think so, and we believe, on the contrary, that the nature and composition of the faunas, generally bear with them the answer to these questions. Two dissimilar parallel faunas are ordinarily characterized by biological differences, manifested by the existence of certain genera, and the

absence of others. Thus we easily recognize a fauna deposited in a muddy bottom by the presence of genera which live buried in mud, and by the absence of others which have need of naked rocks, such as corals and perforating mollusks. Inverse characters distinguish a coralline and a litoral fauna. We might say that these dissimilar parallel faunas form the complement one of the other.

"Two dissimilar successive faunas present inverse characters. If we take them together in their entirety, and over a certain extent, we shall see that in general they do not exhibit biological differences, that they are composed of the same genera; but that the species have been modified, although retaining the same sort of life. We shall easily comprehend these facts on comparing two successive faunas of the same facies—muddy, or coralline.

"It is evident that there is no general rule for the practical resolution of these difficulties, and that these directions, dictated by a judicious method, presuppose an ample collection of palæontological and stratigraphical facts.

"Lastly, there remains the case in which dissimilar faunas are separated by great geographical spaces, and here we recognize the truth of the opinion expressed by M. Agassiz. There is a greater difference between two contemporaneous faunas separated by great geographical distances, than between two faunas of the same region, but of different age, provided the epochs are not very remote. This fact is incontestable, and may be proved by comparisons drawn from all periods. An example, taken from recent epochs, will suffice to make its bearing known. The tertiary fauna of Australia is much like the modern fauna of that country, and not at all like the tertiary fauna of America and Europe. It is the same with these last, and we find, particularly in the fauna, so abundant and so remarkable, that occupied the American continent before the present period, all the types that were precursors of the fauna that we find there to-day, such as the edentata, the apes with thirty-six teeth, etc. In each country the fauna of one epoch derives its characteristics from two factors: the one resulting from that constant law of modification of which every part of palæontology supplies the proof; the other, and less powerful, is the condition of the organization of the preceding fauna that served for a point of departure."

"It is not necessary that we should call the attention of our readers to the importance of these facts, in reference to the explanations we seek in order to elucidate the cause by which the succession of faunas takes place."

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THE FOSSIL HUMAN SKELETON FROM GUADALOUPE.

Letter of Admiral Sir Alexander Cochrane *respecting the* Fossil Human Skeleton, *from* Guadaloupe, *now in the British Museum. Communicated by* S. P. Woodward, F.G.S.

The following document seems never to have been printed, and is not so much as mentioned by Mr. Charles Kœnig, in his letter to Sir Joseph Banks, published in the *Philosophical Transactions of the Royal Society* (vol. civ. p. 107, 1814). Nevertheless it appears to be worth preserving, not only because it is the narrative of the most important person concerned in the acquisition of this celebrated fossil, but inasmuch as it corrects several slight inaccuracies in the popular versions of the discovery, and suggests some considerations which have been overlooked by all other writers.

The occurrence of fossil skeletons at Guadaloupe was first noticed in 1805, by M. Manuel Cortès y Campomanès, an officer of the French government. They were described by General Ernouf, governor of the colony, in a letter to M. Faujas Saint-Fond (*Annales du Muséum*, vol. v. 1805), and afterwards by M. Lavaisse, in his *Voyage à la Trinidad* (1813). Ernouf says that on that part of the windward (or north-east) side of the Grande-Terre, called La Moule, skeletons are found enveloped in "masses de madrépores pétrifiés," very hard, and situated within the line of high water. M. Lavaisse adds that the bed with human skeletons is nearly an English mile in length; and that he found in it hatchets and other implements, made of a basaltic or porphyritic rock, as well as bones. No mention is made of *pottery*.

It appears then that the skeletons were not found "on the main-land of Guadaloupe," as represented by Dr. Mantell and Sir C. Lyell, but on the adjoining island of Grande-Terre, which is separated indeed by a very narrow channel. It is described as a flat limestone country, consisting chiefly of the debris of corals, with here and there single hills of shell-limestone; while Guadaloupe, properly so called, is entirely volcanic.

The block of stone brought home by Admiral Cochrane was originally of a flattened oval form, about a foot and a half in thickness, and weighed nearly two tons. There were no marks of the tool upon it except the few holes evidently made to assist in raising the block, and it had very much the appearance of a huge nodule disengaged from a surrounding mass. The situation of the skeleton in the block was so superficial,

that its presence in the rock on the coast had probably been indicated by the projection of some of the more elevated parts of the left arm. The bones, when first laid bare by the Museum workman, were soft, and had a mouldering appearance; but after an exposure for some days to the air, they acquired a considerable degree of hardness. Sir H. Davy ascertained that they still contained part of their animal matter. The rock is calcareous, with traces of phosphate of lime (found by Dr. Thomson), and was said to be harder than statuary marble. It has a yellowish-grey colour, and is formed of disintegrated white madrepore, with a few fine particles of red madrepore, and occasional fragments of those corals; it contained also the shell of a recent land snail (*Helix acuta*), and the "magpie" Trochus (*T. pica*), a common sea-shell of that coast.

This subject is also treated of by Baron George Cuvier, in his famous *Discours sur les Révolutions de la Surface du Globe* (Ed. 3, Paris, 8vo, 1825; originally published in connection with his *Recherches sur les Ossemens Fossiles*, of which the best edition is the 4th, 8vo, Paris, 1834, with 4to Atlas). After referring to the skeleton obtained with so much labour by General Ernouf, which came into the possession of the English, he says that *more recently* General Donzelot had extracted another example, now placed in the Cabinet du Roi (Jardin des Plantes), at Paris, and of this he gives a description and figure. It was imbedded in a softer sandstone, also containing a recent land shell (*Bulimus Guadalupensis*, Fér.) of a species still inhabiting the island. The lower jaw is preserved, but the skull is wanting, as in the former specimen. The other skeleton is extended in the usual position of the burial; but this has the knees doubled up, and seems to have been interred in the sitting position customary among the Caribs. They may have belonged to individuals of two different tribes. General Ernouf explains the circumstances by reference to a tradition of a battle and a massacre on this spot, of a tribe of Galibis by the Caribs, about the year 1710. The name Galibi was said to have belonged to an ancient tribe of Caribs of Guiana, but according to a suggestion of Sir Joseph Banks, it may have originated in the substitution of the letter *l* for *r*, in the word *Caribee*.

The only other article of any importance connected with this subject is a Report by Dr. James Moultrie, on a Skull of the Guadaloupe Fossil Human Skeleton (communicated by Dr. Shepard to *Silliman's American Journal of Science and Art*, vol. xxx. p. 361, New Haven, 1837). The remains consisted of four cranial bones, a fragment of the lower jaw, and the lower part of a thighbone, imbedded in a matrix exactly like a

portion of the rock given by Mr. Kœnig, from the British Museum specimen, to which they were said to have originally belonged. They were brought from Guadaloupe by M. L'Herminière, and placed in the museum of the Literary and Philosophical Society of South Carolina, in August 1816, and were purchased in the November following by the Medical College of the State, for its Museum in Charleston. "These relics," says Dr. Moultrie, "have been supposed to belong to the head of an individual of the Carib race. This is undoubtedly a mistake. The anterior posterior diameter is too short, the occipital region too flat, and the lateral and vertical developments too full, upon a reconstruction of the cranium, to justify such a supposition. Compared with the cranium of a Peruvian in the Museum of the Medical College of the State of South Carolina, the craniological similarity manifested between them is too striking to permit us to question their national identity."

Without attaching too much importance to this ethnological opinion, it may yet be doubted whether the interment of the skeletons was quite so recent as supposed by General Ernouf. Admiral Cochrane has suggested the probability that it took place before the sea had encroached upon that portion of the shore, so as to cover it at high water, a change of no great amount, as the tides in the Antilles only amount to two or three feet; and the volcanic activity of La Souffrière, in Guadaloupe, may well have caused such a slight oscillation of level on a neighbouring shore. The beach must have consisted of loose sand at the time of the interment of the bodies, and the process of solidification may have taken place gradually, as indicated by the subsidence and displacement of some of the bones. The narrative of Admiral Cochrane, and the statement of Mr. Kœnig, equally convey the impression that the coral sand formed a sort of concretionary mass around the bodies, which doubtless supplied the phosphoric acid since detected in the stone. If Guadaloupe was densely wooded like most of the West Indian Islands when first discovered by Europeans, it would have been equally natural for the savage inhabitants to guard against hostile intrusion, or settle their own private differences, and bury their dead on the open sandy shore. There are great accumulations of shell-sand at the Island of Ascension, described by Mr. Darwin, and to them the turtles come to bury their eggs: it sometimes happens that the beach consolidates before the young are hatched, and when quarried for building purposes, the petrified eggs containing bones of the little turtles are exposed to view, as in the specimen presented by Mrs. Kenyon to the Geological Society. Deposits of calcareous sand are also cemented by the percolation of fresh water, as mentioned by Sir Alexander Cochrane. The ancient

province of Pamphylia, in Asia Minor, is described by Professor E. Forbes and Captain Spratt as being wholly composed of *travertine*, full of holes and caverns, in which innumerable streams disappear from sight to burst forth afresh after a passage underground. On this coast the beaches are all petrified, and the fisherman who runs his boat ashore upon what appears to be a bank of sand or shingle, will find her bottom stove in upon a rock. The admiral refers to the bone-breccia of Gibraltar, in terms which make it desirable to say that the rock itself is a mass of gray secondary limestone, of uncertain age, containing *Terebratulæ*, similar to *T. fimbria* of the inferior oolite; and that the reddish coloured rock with *monkey-bones* is only found in caves and fissures. It is a modern deposit, such as occurs in all limestone countries; in this case the caverns having been much frequented formerly by soldiers of the garrison and pic-nic parties, numerous tobacco pipes and chicken-bones have become mingled with human remains and those of the older natives of the rock.

(Copy of Letter.)

64, Welbeck Street, *August* 27, 1813.

"My Lord—The stone that I brought from Guadaloupe, of which I spoke to your lordship, was found near to the port of La Moulle, situated on the Windward side of Grande Terre. The French Government had directed this and another that was discovered to be carefully cut from the Rock, an operation very difficult to effect, from their position being within the line of high water, consequently the workmen could only be employed when the tide had receded from the Shore, and to preserve the Body entire they were under the necessity to undermine it, carefully removing the surrounding Rocks. The first that was brought round to the seat of Government was I understand sent to France in a Ship of War, and this was to have followed had the Island not been taken at the period it was. The expense of cutting out the one I brought home I was told exceeded three thousand Pounds, but of this I can speak with no kind of certainty, as the administration carried with them all their Books and Papers. By a man of considerable abilities in mineralogy, now resident at Guadaloupe, I was informed that the body contained within this stone lies in a diagonal position, the side appearing on the upper edge of the stone, he described this to me and pointed out the arm and some other parts. I had it in contemplation to saw it in two, so as to have cut the body asunder in a line from head to foot, I afterwards thought it better that it should be conveyed to England in its present state. There is no trace in the History of the Island that can lead to the cause of this extraordinary petrefaction, nor have I heard of any conjecture as to its original formation. My idea is that previous to the discovery of America the inhabitants were in the habit of burying their dead

near the Sea in the Sand, the dryness of which had kept the body in a state of preservation until the Sand had formed an incrustation round it, in this it may have been assisted by the filteration of Water from the Sea, which is known in that Country to contain much calcareous matter, as is visible in the formation of the white coral; in many places the spring Water has the same effect, which probably was an agent on the present occasion, as the Sea appears to have gained considerably upon the Sand in that Quarter by its annual progress; that part which was originally dry became submersed, and now forms the Rocks upon the Shore, out of which these 'Galibies' or human Bodies have been cut (this being the name given by the French Chemists).

"At Gibraltar I have observed many bones in the Lime stone of which that Rock is composed that resembled those of the human Body, but upon examination they were discovered to be of the Monkey Tribe. I have also observed there the constant increase of Matter occasioned by the filteration of Water from the Rock, now if one of those Animals happened to die under this filteration, the deposited Matter would soon form an incrustation round the body, altho' this could not take place at Guadaloupe in the same manner as at Gibraltar, I still consider them as analogous to each other, as the same effects are I believe produced in many parts of England.

"I submit these my ideas with much diffidence, well knowing that upon the Stone being inspected more able conjectures will be formed by those better competent to decide the question.

"I have the honour to be your Lordship's

"Most obedt. humble Servt.

"ALEXR. COCHRANE.

"The Honble. Lord Melville, etc. etc. etc."

LIFE IN THE DEEP SEA.*

THERE is a curious tendency in the human mind to allow itself to be misled by negative evidence. It arises chiefly from the conservative spirit of indolence which does not like to be disturbed in its repose, and which is better satisfied to believe that things do not exist, because we have not found them, than to undertake the labours of a fresh search. There is likewise a readiness to establish a scientific orthodoxy upon insufficient evidence, and to resent, as a pestilent heresy, whatever facts, opinions, or conclusions militate against the canons of credence which have been arbitrarily laid down. A good philosophical training removes prejudices, and establishes a readiness to believe upon sufficient proof being adduced, propositions that contradict its previous ideas. But while professed students of science feel

* *The North Atlantic Sea Bed. Part I.* By E. C. Wallich, M.D., F.L.S., F.G.S. Van Voorst.

this influence in the earlier portions of their career, they often suffer a psychological ossification as age creeps over them, and they become as great opponents of novelty as if the powers of knowledge were exhausted and nothing new could possibly be true. Of course, as our store of facts grows larger, and sound induction establishes a larger number of principles from which accurate deductions can be made, many of the discoveries of science will simply realize anticipations previously formed; but we must still expect that Nature will be for ever a region of wonder and surprise, in which many things that were undreamt of, or which were even inconceivable before their discovery, will come to us with all the unquestionable credentials of belief.

Every department of science can offer illustrations of these views; but in none have old conceptions been more completely revolutionized than in marine zoology, so far as relates to the inhabitants of the profound depths of the sea. It was assumed that life rapidly diminished with increasing profundity, and that our plummets soon arrived at a region where no "dim beams," "amid the streams," "wove their network of coloured light," but where the world of waters rested for ages in unbroken silence and lifeless gloom. There was, however, little excuse for the extent to which these opinions were carried; for, as Dr. Wallich reminds us, the late Sir John Ross published in 1819 an account of his having obtained in Baffin's Bay various "sea-worms," "shrimps," and other creatures from "depths greatly exceeding those at which animal life was supposed to exist; and nearly thirty years subsequently Sir James Ross also reported having dredged up living creatures from great depths in the Antarctic seas;" but these important discoveries met with no attention, and it may be fairly said that the capture of the deep sea starfishes by the "Bulldog" was the first incident that materially modified pre-existing and erroneous views. To show the process of reasoning adopted by distinguished men in reference to this subject, Dr. Wallich quotes Mr. Page's *Advanced Text Book of Geology*, that, "according to experiment, water at the depth of 1000 feet is compressed one three hundred and fortieth of its own bulk, and at this rate of compression we *know* that at great depths animal and vegetable life, as known to us, cannot possibly exist." If Mr. Page had written "we guess," instead of "we know," he would have more accurately described the groundwork of a decision which naturalists had arrived at by common consent, without either examining the deep sea bed to ascertain what it really contained, or without acquainting themselves with some of the principal conditions that would determine whether or not it could offer the means of existence to any living thing. In the same spirit which dictated Mr. Page's remarks, Professor Philips,

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in his *Origin and Succession of Life on the Earth*, expresses the belief that at 300 fathoms life is extinct, thus completely ignoring the 800 fathoms sounding from which Sir John Ross brought up a *caput medusæ*, and the various creatures he obtained at a somewhat smaller depth.

In science, as in other spheres of human activity, an unreasoning credulity often follows an equally unreasonable scepticism, and we are glad to notice that Dr. Wallich, while laudably anxious as "King of the Deep Sea," to increase the number of his subjects, boldly resists arguments in their favour, which although tempting are not conclusive. Thus Professor Ehrenberg assumed that the presence of undecomposed fleshy matter (sarcode) in foramenifera, whose shells were found at very great depths, was a proof that they had been alive in the situation in which they were discovered; but Dr. Wallich demonstrates the fallacy of this reasoning, although he expects its conclusion will ultimately prove to be correct, and that hereafter specimens will be obtained whose *vital movements* will leave the question in no doubt.

Before examining the circumstances under which deep sea organisms live, we will advert the most startling acquisitions which Dr. Wallich made, especially to his famous starfish hawl. He tells us the sounding was taken in lat. 59° 27′ N.; long. 26° 41′ E., about halfway between Cape Farewell and the north-west coast of Ireland. The depth was 1260 fathoms, and "adhering to the last fifty fathoms of the line, which had rested on the ground for several moments, were thirteen *Ophiocomæ*, varying in diameter across the arms from two to five inches." These animals moved their arms after reaching the deck. The starfishes so remarkably obtained appeared to be living in the midst of their "normal haunts." In their digestive cavity was found a quantity of fresh-looking *globigerinæ*, and they seem to have been associated with creatures of a still higher type. Thus we read "in these soundings (including that in which the starfishes were obtained) taken in the undermentioned positions and depths,—namely, lat. 59° 27′ N., long. 26° 41′ W., depth 1260 fathoms; lat. 58° 23′ N., long. 48° 50′ W., depth 1913 fathoms; and lat. 56° 43′ N., long. 11° 55′ W., depth 1268 fathoms,—many cylindrical tubes occurred, varying from one-eighth to one-half an inch in length, and from one-fiftieth to one-seventieth of an inch in diameter. These were built up almost exclusively of small globigerine shells, and still more minute calcareous debris cemented together. Two or three such tubes were found by me in each of these soundings; but I failed to extract the animals from them in a sufficiently perfect condition to admit of identification. I am nevertheless able to state positively that the tubes contained some species of Annelid, and

think it is highly probable that certain borings, to be seen on foramenifcrous shells in the same deposits, may have been effected by it. But whether this be the case or not, it is quite clear that an Annelid lives at the depths indicated, and there builds up its tenement."

At 682 fathoms Dr. Wallich met with a Serpula, and a cluster of apparently living polyzoa, and also a minute living Spirorbis. From a depth of 445 fathoms he fished up a couple of living "amphipod Crustaceans," and a "filamentous Annelid," and when we consider how these creatures could accommodate themselves to such localities, we have to take into account the "extraordinary fact that the *Ophiocomæ*, the *Serpula, the Spirorbis* of the deep soundings,—one and all belong to well-known littoral species." From these facts Dr. Wallich observes: "We are irresistibly led to the inference that their acclimatization must have kept pace, during a vast sequence of generations, with the changes going on in the portion of the sea bed inhabited by them, and hence that, under sufficiently favourable circumstances, species may accommodate themselves to conditions differing so widely from those under which they were originally created, that their subjection to them, under circumstances less favourable, inevitably results in their extinction."

From what is known of deep sea life, we should be cautious in pronouncing judgment upon the far deeper portions of the ocean bed than our investigations have yet reached. There may be, probably is, a limit to the descending zones of life, but where it lies, seems rather for experiment than for deductive reasoning to tell. The more immediate question for solution is, how the creatures that have been discovered manage to live, under circumstances differing so widely from those in which we are accustomed to trace the mutual relations and dependance of animal and vegetable forms. Vegetable structures have not been found alive at greater depths than 2400 feet, while animals are now known to exist at 15,000 feet below the surface level. If any sort of plant lives much below the above-mentioned depth, it must perform its functions without the stimulus of light; and if animals exist far below the regions of vegetable life, they must be released from that dependance upon the latter, which we have been accustomed to regard as an universal law. Such are the interesting problems which the marine zoologist has to solve.

The pressure of great depths only opposes itself to life under peculiar forms. At a depth of a mile it amounts to 2640 lbs. on every square inch, or 160 times as much as we have to sustain on the surface of the globe. A close vessel would need immense strength to resist anything of the

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kind, but if the pressure from within can equal that from without, its physical force would not necessarily destroy any organism exposed to its effects. Dr. Wallich judiciously indicates the difference between certain well-known experiments and the conditions under which deep sea creatures live. Thus, "in the case of pieces of wood and meat, and corked bottles containing air, which have been sent down to great depths, in order to demonstrate the effects of pressure, it is evident that precisely those conditions are present which are never to be met with in creatures constituted to live under it. In short, they prove too much; for they prove clearly that, in defiance of all obstacles, a state of equilibrium is rapidly engendered between the interior and the exterior of the wood, the mutton, and the bottles, and that whensoever this takes place no further change is experienced. If suddenly submerged, that is to say, before the pressure has time to overcome the resistance of the cellular and fibrous tissues of the two first, and of the earth employed in the last, diminution of bulk and consequent compression of the structure must inevitably result; but, on the other hand, if the submergence be gradual, the diminution in bulk is by no means a necessary consequence, and the change brought about is a simple displacement of a lighter medium by a heavier, according to a well known law of fluids." This is no doubt right in principle, but scarcely correct in detail, as all portions of an organism may not be thus permeable, and those which the heavier fluid cannot penetrate, must be subject to the pressure which it exerts on all sides. It will, however, be admitted without difficulty, that marine animals like the star-fishes or the annelids of Dr. Wallich's dredgings would not be injured by the weight of water, if gradually submerged; and having disposed of one difficulty of deep sea life, let us turn to another, in which the function of respiration is concerned.

Some valuable experiments on board the French ship "Bonité" give us an insight into the quantity of gaseous matter existing in the water at different depths, which appears, within the limits investigated, to increase as the surface is left behind. From these investigations, and on other grounds, Dr. Wallich concludes that "since the tendency of fluids to absorb gaseous bodies is constant under all circumstances, although, as already stated, the quantity they are capable of appropriating increases with the pressure, it follows that the deeper the stratum of water, the greater must be the amount of gaseous matter held in solution by it." But the ocean is not a closed vessel, in which the liquid and the gas are squeezed together without possibility of escape, and if water at a mile down contains more air than the strata above it, the effect must be produced by the operation of a powerful attraction increasing with the compres-

sion and depth, so that every layer of water drags the air from the layer above it, and is in turn robbed by the stratum beneath itself. This may be so, but we do not think it is proved to be the case, in an increasing ratio throughout all depths. The "Bonité" experiments were not conducted at great depths, the greatest being only 2243 Paris feet. They seem however to show that, while the quantity of nitrogen is diminished as the pressure is augmented, that of carbonic acid and oxygen is considerably increased, and might accumulate to a deleterious extent if it were not rendered innocuous by the constant formation of carbonate of lime.

Within considerable limits of downward range, we may conclude from the preceding facts, that deep sea creatures are provided with the means of breathing in water, in the same way as their similarly organized inhabitants of the ocean nearer the surface level; but how do they feed? The starfish may devour the humble creature that inhabits the foramineferous shell, but what is the latter to do when dinner-time comes? Dr. Wallich admits the difficulty of furnishing an answer without appealing to a process of nutrition for which he says there is no acknowledged precedent. It is the custom of scientific men, upon insufficient evidence, and in the face of well-known facts, to assume that no animal can assimilate inorganic matter that has not previously been brought within the vital circle by vegetable forms. Dr. Wallich conjectures that if the Protozoa* can separate from the water the carbonate of lime to form their shells, they may also be able to make a similar direct use of other inorganic materials to serve as food. It is certainly, as he says, in vain that we attempt to establish a definite line of demarcation between the two kingdoms of nature, and although some philosophers still "stand upon the ancient ways," the majority are disposed to surrender the notion that the lowest living forms can be distinctly divided into animals and plants. Further researches may show more clearly the gradutions by which animal and vegetable characteristics are blended together; but if respiration enables the animal to assimilate the oxygen of the air, and, through the introduction of salts of iron into the stomach, that metal finds its way into the blood, the first link of the chain of connection is found in the highest forms of animated being.

The geological importance of Dr. Wallich's researches is very great, as strata cannot now be considered to have been formed in shallow seas, *merely* on account of their containing the remains of animals that we are accustomed to associate with moderate depths, nor are the biological aspects of the new

* Literally "first living things"—that is to say, simple or elementary creatures, at the beginning of the zoological scale.

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truths less singular and instructive. From *à priori* reasoning it might have been imagined that if, through long ages, a littoral species of an animal so highly organized as a starfish had become acclimated to totally different conditions of depth, pressure, darkness, and aeration, it would also have undergone constitutional changes that would have been reflected in its structure, but no such alteration seems to have taken place in the subjects of Dr. Wallich's investigation. We inquire whether the deep sea ophiocomæ which belong to a littoral species were themselves in earlier life the occupants of shallower waters, and made a voluntary or involuntary migration to the depths below; or whether they were the born children of the abyss, the lineal descendants of some pilgrim fathers of their race whose wanderings date back to the period when changes of level and in the distribution of land and water necessitated an alteration of their abode. The *Ophiocoma granulata* appears to be a creature of determined adhesion to a particular type. It ranges from the confines of the Arctic circle to the British shores, able to make itself at home from ten fathoms to 1260, and in either of these extreme conditions, or in any of their intermediaries, to rear a family for the perpetuation of its name.

No similar adaptability seems to belong to any member of the vegetable world. Dr. Wallich met with no proper Algæ below two hundred fathoms, and his deep sea dredging only yielded Diatoms whose frustules "indicated a molecular condition of the protoplasmic matter, differing so materially from that observable in similar organisms taken in a living condition in shallow water as to render it certain that the vegetable life ceases at a limit far short of that to which animal life has ever been shown to extend." This assertion may be too dogmatic to suit the actual condition of our knowledge; but if it should be found that there are regions in which, so to speak, every animal is his own vegetable, it will reveal to us fresh secrets pertaining to the great mysteries of organization and life.

A book like Dr. Wallich's would naturally command a large circle of readers, and we regret that its mode of publication will restrict it to a very few. Science is not so profitable that many of its votaries can afford fifteen shillings for a stout quarto pamphlet, offered as an instalment of the entire work. We can hardly imagine that the profundity of his researches appeared to so able an observer to necessitate a corresponding elevation of the price of the narrative in which they were enshrined, and we should like to know whether he has been a victim of the "Lords Commissioners of the Admiralty," under whose sanction, the title-page informs us, the *North Atlantic Sea Bed* has been brought out, or whether his worthy publisher, who has done so much

for zoological science, determined in this case to address himself exclusively to that very limited class whose pecuniary and cerebral developments go hand in hand. The less wealthy student to whom costly pamphlets are unattainable luxuries need not, however, lament his fate, as a concluding extract from Dr. Wallich will give him the cream of the whole matter, and show, for his economical edification, that:

1. "The conditions prevailing at great depths, although differing materially from those which prevail near the surface of the ocean, are not incompatible with the maintenance of life.

2. "Assuming the doctrine of single specific centres to be correct, the occurrence of the same species in shallow water and at great depths, proves that it must have undergone the transition from one set of conditions to the other with impunity.

3. "There is nothing in the nature of the conditions prevailing at great depths to render it impossible that creatures originally, or through acclimatization, adapted to live under them should become capable of living in shallow water, provided the transitions be sufficiently gradual, and hence it is possible that species now inhabiting shallow water may at more anterior periods have been inhabitants of great depths.

4. "On the one hand, the conditions prevailing near the surface of the ocean render it possible for organisms to subside after death to the greatest depths, provided every portion of their structure is freely pervious to fluid; on the other hand, the conditions prevailing at great depths render it impossible for organisms still constituted to live under them to rise to the surface, or for the remains of these organisms after death to make their appearance in shallow water.

5. "The discovery of even a single species living normally at great depths warrants the inference that the deep sea has its own special fauna, and that it has always had it in ages past; and hence that, many fossiliferous strata, heretofore regarded as having been deposited in comparatively shallow water, have been deposited at great depths."

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RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

BY CHARLES CHAMBERS.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1862. Day of Month.	Reduced to mean of day. Barometer corrected to Temp. 32°	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9.30 A.M.	Daily Range.	At 9·30 A.M.; 2 P.M.; and 5 P.M. respectively. Proportion of Sky clouded.	Direction of Wind.	Rain, read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
July 1	29·907	58·8	52·1	·80	·401	67·4	48·3	19·1	9, 10, 8	W, W by N, W by N.	·000
„ 2	29·784	56·5	47·9	·75	·347	66·5	56·1	10·4	10, 9, 5	SW, WNW, WSW.	·000
„ 3	29·863	49·6	46·7	·91	·333	57·7	48·4	9·3	10, 10, 9	W, WSW, SW by S.	·000
„ 4	29·868	56·2	45·1	·69	·315	63·9	45·3	18 6	7, 7, 7	SW by W, SW, SW.	·257
„ 5	29·545	60·3	56·3	·88	·462	70·8	51·6	19·2	10, 7, 8	E by S, S by W, S by E.	·025
„ 6	...	..	...	...	...	67·5	56·8	10·7	...	...	·234
„ 7	29·620	56·7	49·1	·78	·362	64·2	55·0	9·2	9, 10, 5	SW by S, SSW, SW by S.	·020
„ 8	30·045	62·0	51·8	·71	·397	71·0	52·9	18·1	7, 5, 3	W, SW by W, SW by S.	·319
„ 9	29·985	55·2	54·5	·98	·435	64·3	53·7	10·6	10 10, 10	SSW, SW by S, SW.	·015
„ 10	29·754	55·8	48·4	·78	·353	64·3	55·0	9·3	10, 9, 10	SW by W, W, SW by W.	·132
„ 11	29·889	53·8	40·1	·63	·265	62·2	45·8	16·4	10, 5, 7	W by N, W, W.	·110
„ 12	29·435	57·8	54·5	·89	·435	67·5	51·5	16·0	10, 10, 9	SSW, SW by S, SW.	·382
„ 13	...	...	...	...	...	70·0	49·5	20·5	...	...	·126
„ 14	29·835	61·7	56·4	·84	·464	70·2	56·5	13·7	8, 6, 10	SW, SW by S, SW by S.	·002
„ 15	29·759	58·0	48·6	·73	·356	66·3	50·9	15·4	3, 8, 3	S, SW by S, SW.	·002
„ 16	29·749	55·6	50·8	·85	·384	63·9	49·8	14·1	7, 5, 9	W, SW, NW by W.	·111
„ 17	29·878	56·7	49·6	·79	·368	64·9	46·9	18·0	8, 7, 10	SW, SW by S, SW by S.	·050
„ 18	29·977	59·0	43·1	·58	·294	67·4	54·9	12·5	3, 3, 3	W, NW by W, W by S.	·026
„ 19	29·975	56·8	53·2	·89	·416	66·4	53·4	13·0	10, 10, 8	SSW, SW by S, SW by S.	·003
„ 20	...	...	...	...	..	67·3	49·7	17·6	...	...	·000
„ 21	30·193	59·3	44·3	·60	·307	67·3	52·6	14·7	4, 8, 3	NNW, W, W by S.	·000
„ 22	30·153	58·0	47·1	·69	·338	66·2	44·7	21·5	4, 10, 10	SW, SW, SSW.	·000
„ 23	29·931	53·5	53·4	1·00	·419	61·4	51·1	10·3	10, 10, 10	NNE, N by E, NW.	·197
„ 24	29·983	60·1	57·3	·91	·478	68·0	51·8	16·2	10, 8, 4	S, SW by S, SW by S.	·031
„ 25	30·062	63·1	50·4	·65	·378	70·4	56·7	13·7	3, 1, 1	WSW, W, W.	·000
„ 26	30·018	66·5	55·6	·70	·451	74·8	49·0	25·8	0, 1, 1	SW by S, SSW, SW.	·000
„ 27	...	...	...	...	...	69·2	52·4	16·8	...	...	·015
„ 28	30·109	61·6	47·3	·62	·340	69·5	46·4	23·1	2, 2, 3	SW by S, NE, —.	·000
„ 29	30·050	62·0	47·6	·62	·344	70·4	48·7	21·7	0, 10, 8	NE, NW by N, NW.	·000
„ 30	30·074	60·0	47·7	·66	·345	69·0	53·3	15·7	7, 5, 4	N, SW, W.	·000
„ 31	30·058	60·6	52·6	·77	·408	69·8	49·7	20·1	10, 3, 4	SW by S, WSW, SW.	·000
Monthly Means.	29·907	58·3	50·1	·77	·378			15·8	...	...	2·057

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER—JULY 1862.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour. 12																																
1	7	14	6	6		15	15	6	7	15	8	9	7	12	10	10	10	12	3	9	10	2	5	4	18	1	5	2	2	5	4	8·1
2	8	7	7	6		12	13	8	6	9	8	9	9	6	6	6	9	4	4	8	4	2	3	5	5	2	5	1	1	2	4	6	7·8
3	14	17	8	7		11	8	9	10	12	5	6	8	7	8	9	8	15	5	13	8	3	6	6	18	3	3	4	3	2	6	6	8·0
4	18	8	6	7		6	8	11	13	5	7	6	12	9	9	8	18	9	12	8	10	5	8	8	5	5	2	2	3	4	4	7	8·8
5	49				8	18	20	15	12	15	8	7	6	11	5	10	7	14	8	12	9	4	14	13	6	4	1	1	5	6	2	7	8	8·9
6					18	20	18	20	18	15	11	12	6	14	11	12	10	9	13	18	11	4	10	9	11	22	18	5	5	5	6	5	14	9·1
7					21	18	6	18	17	15	12	13	17	13	13	15	12	13	21	20	13	3	11	8	12	20	5	3	6	6	9	6	11	11·0
8					20	18	20	18	19	18	12	15	20	16	14	15	12	12	27	20	11	4	8	14	18	5	3	3	8	9	6	13	17	12·6
9					23	7	17	8	19	15	13	13	8	14	15	15	12	12	23	20	12	7	8	20	5	2	5	5	9	8	3	6	15	13·4
10					14	17	15	19	15	13	13	8	16	14	15	12	15	12	21	20	16	7	9	17	4	1	2	2	8	7	4	7	21	13·1
11					11	10	11	10	17	10	8	12	22	15	15	15	18	12	13	27	18	13	6	13	20	1	5	6	9	8	5	8	24	11·4
12					13	10	7	11	21	17	9	20	15	22	15	18	12	13	27	19	9	17	10	17	15	38			9	8	10	21	14·9
P.M. 1					13	22	14	25	14	11	11	19	15	26	19	19	15	12	27	19	11	5	7	23	17				7	7	25	15·7
2					14	23	16	23	18	12	18	20	20	20	19	18	17	11	30	19	10	8	9	21	16				8	6	25	15·7
3					15	25	14	21	18	13	10	17	20	23	22	21	19	10	25	19	10	8	8	20	15				9	7	26	15·5
4					19	19	18	26	16	9	11	18	18	23	19	17	10	7	25	20	11	10	7	21	13	11	1		6	6	24	14·6
5					19	20	14	23	17	9	10	22	19	22	12	11	14	9	22	14	12	10	6	28	14	12	3	1	8	8	25	14·4
6					21	25	17	25	18	9	8	17	22	19	13	8	7	7	23	19	12	12	4	29	7	10	1	1	6	7	17	12·5
7					18	19	16	22	18	12	8	15	17	18	16	9	11	5	17	13	8	8	4	25	10	12	2	1	5	5	17	11·5
8					16	18	14	16	17	13	4	14	16	16	9	11	13	7	17	13	8	7	3	28	7	163	2	11	5	6	13	9·7
9					15	13	11	17	19	12	7	10	12	17	8	11	7	4	10	8	6	5	1	21	2	6	1	3	18	4	10	8·8
10					12	10	7	16	17	7	8	11	17	9	8	8	8	3	10	9	4	1	2	20	2	2	4	12	6	10	8·3
11					5	8	8	9	8	11	7	8	11	15	8	7	8	5	11	6	5	2	4	19	5	7	5	2	4	14	9·2
12					7	8	7	13	6	8	8	8	12	10	8	9	10	6	9	1	1	2	2	17	2	8	7	2	3	10	7·9
Total Daily Movement.	332	388	177	347	425	370	290	401	320	220	267	273	394	287	295	267	242	387	349	221	131	143	376	336	139	265	157	131	367	11·1		

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1862. Day of Month.	Reduced to mean of day. Barometer corrected to Temp. 32°.	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Aug. 1	29·989	66·2	48·6	·56	·356	73·7	52·2	21·5	1, 1, 1	SW, SW, by W, SSW.	·000
„ 2	29·964	61·5	50·3	·69	·377	70·9	51·8	19·1	10, 6, 10	WSW, W, W.	·000
„ 3	...	...	...	...	...	72·7	48·8	23·9	...	...	·068
„ 4	29·913	62·9	50·2	·65	·376	71·0	46·9	24·1	6, 2, 3	SW by S, SW by S, S by E.	·000
„ 5	29·646	61·8	49·9	·67	·372	69·4	57·4	12·0	4, 5, 4	SSW, SSW, SSW.	·000
„ 6	29·772	59·3	47·2	·66	·339	67·5	51·0	16·5	4, 8, 4	W by S, SW by S, SSW.	·003
„ 7	29·390	55·8	54·6	·96	·436	66·2	54·4	11·8	10, 7, 7	SSE, SW, SW.	·115
„ 8	29·516	54·0	46·8	·78	·334	64·5	51·8	12·7	8, 8, 7	SW, W by S, WSW,	·171
„ 9	29·771	55·9	47·8	·76	·346	63·3	53·5	9·8	8, 10, 10	NWbyW, NWbyW, NbyW.	·115
„ 10	...	...	...	...	...	63·7	46·3	17·4	...	...	·000
„ 11	30·112	57·0	48·4	·75	·353	64·0	53·9	10·1	10, 9, 8	NW, SW by S, W by N.	·020
„ 12	30·114	60·1	51·8	·76	·397	67·7	48·3	19·4	8, 6, 10	SSW, SW, SW by W.	·000
„ 13	29·920	59·8	55·6	·87	·451	67·7	50·5	17·2	10, 9, 10	NW, S, SSW.	·000
„ 14	29·743	57·9	57·6	·97	·473	65·8	54·3	11·5	10, 7, 10	SW by S, SW by S, WSW.	·350
„ 15	29·773	59·2	56·7	·92	·468	66·0	53·8	12·2	9, 9, 6	SW by W, SE by E, S by E.	·377
„ 16	29·759	56·4	55·6	·97	·451	62·4	51·8	10·6	10, 10, 10	NNE, N by E, N.	·186
„ 17	...	...	...	...	...	59·0	55·7	3·3	...	...	·944
„ 18	29·946	55·2	48·6	·80	·356	62·3	54·6	7·7	10, 10, 2	N, NW, NE by N,	·317
„ 19	29·934	62·8	53·7	·74	·423	70·0	47·5	22·5	1, 1, 0	SW by S, SW, SW by S.	·008
„ 20	29·984	59·9	53·6	·81	·422	67·3	51·0	16·3	9, 10, 10	S by W, WSW, NW.	·000
„ 21	29·899	63·3	56·2	·79	·460	71·0	56·0	15·0	4, 9, 9	S by W, S, SW by S,	·000
„ 22	29·904	59·3	49·0	·70	·361	67·6	55·0	12·6	10, 4, 7	NNW, W by N, W by N.	·016
„ 23	30·158	59·2	50·1	·74	·374	67·3	46·2	21·1	4, 6, 10	SW, SW, SW.	·000
„ 24	...	...	...	...	...	67·3	44·5	22·8	...	...	·002
„ 25	30·182	59·8	46·0	·63	·325	67·9	47·3	20·6	2, 1, 1	E, E, E by N.	·000
„ 26	29·888	62·6	51·0	·68	·386	70·5	51·9	18·6	5, 3, 4	E, E by S, E by S.	·000
„ 27	29·953	61·3	50·1	·69	·374	69·5	54·0	15·5	1, 4, 4	NE by N, NE, NE.	·000
„ 28	30·089	60·2	48·6	·68	·356	67·8	47·8	20·0	2, 3, 2	NE by N, NNE, NE.	·000
„ 29	30·133	56·6	51·0	·83	·386	64·6	47·6	17·0	3, 10, 10	NE by N, N by E, NNE.	·000
„ 30	30·065	57·0	49·0	·76	·361	65·0	47·9	17·1	4, 7, 4	NNE, NE, N by W.	·000
„ 31	...	...	...	...	...	66·3	54·9	11·4	...	...	·000
Monthly Means.	29·905	59·4	51·1	·76	·389			15·8			2·692

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—Aug. 1862.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
12	10	2	4	4	7	16	9	16	7	4	6	3	5	10	3	2	14	13	1	6	1	5	6	1	5	10	7	1	1	3	5	6·0
1	6	5	3	4	8	15	11	14	9	6	5	2	2	5	3	3	15	10	0	4	3	5	5	3	3	7	11	2	2	2	4	5·7
2	5	4	3	3	5	11	14	15	4	5	4	2	5	9	3	3	12	12	1	5	4	4	5	3	3	8	11	1	1	2	4	5·7
3	5	3	3	3	7	12	11	11	3	5	4	2	4	4	3	11	10	16	2	6	1	6	5	3	3	9	7	1	1	2	3	5·4
4	7	6	1	1	4	13	20	24	6	3	6	0	6	0	2	7	7	8	5	5	2	8	6	5	5	6	8	1	2	2	3	5·6
5	9	5	3	4	8	16	22	27	17	8	5	4	8	3	1	10	12	10	6	6	3	9	7	5	6	8	8	2	2	3	3	5·9
6	15	7	5	7	14	18	25	20	10	6	7	5	12	7	5	16	13	5	7	7	4	14	8	6	7	9	8	3	5	6	7	6·9
7	18	8	4	10	16	22	27	20	14	10	8	7	14	7	3	11	10	15	7	7	8	16	9	7	8	10	8	5	6	9	10	8·8
8	18	9	6	13	15	19	29	19	14	13	8	7	13	10	3	11	11	14	11	8	6	15	9	8	9	11	9	6	7	10	11	9·9
9	16	11	6	11	13	21	32	14	13	8	8	8	15	8	2	14	14	16	11	9	8	14	10	8	9	12	10	7	8	11	12	10·5
10	14	10	6	11	14	24	33	14	12	8	5	8	13	8	1	14	14	16	11	11	9	13	10	8	10	13	12	8	7	11	12	10·7
11	17	11	6	12	19	29	35	17	11	11	6	10	17	9	4	15	17	17	12	12	8	15	11	9	11	15	15	11	9	10	11	11·1
12	18	9	6	14	30	24	21	22	11	11	7	12	15	6	3	1	11	8	5	15	10	8	8	5	5	20	16	12	10	10	10	12·2
1	15	9	5	13	27	28	18	11	12	8	12	13	13	3	5	10	12	8	6	16	4	3	10	6	4	25	15	11	11	10	7	12·1
2	13	8	3	16	26	26	18	10	9	9	9	12	11	6	6	14	8	6	14	4	5	10	6	5	6	21	16	8	9	12	11	11·8
3	15	7	3	14	23	27	22	16	14	13	9	14	7	3	12	8	7	14	2	5	8	6	5	6	6	21	16	6	8	13	4	11·5
4	17	7	3	16	24	22	19	13	7	9	6	11	4	1	14	8	4	13	1	5	10	5	5	5	14	13	9	6	8	12	1	11·2
5	13	7	3	15	22	17	11	8	5	6	3	10	2	1	12	5	3	10	1	5	5	1	2	2	15	12	4	3	11	2	10	9·5
6	11	6	3	18	23	17	11	5	6	3	10	14	3	1	12	5	6	10	0	4	8	5	1	2	17	10	3	3	1	3	5	8·0
7	9	7	6	18	19	14	6	4	5	4	6	10	2	1	14	7	3	10	1	6	5	2	0	1	10	9	2	2	3	2	3	7·8
8	7	9	7	19	19	19	9	4	7	5	4	2	2	1	15	12	2	7	2	6	7	6	2	1	15	8	3	2	3	2	7	7·3
9	5	5	6	17	15	20	9	4	4	6	5	2	2	1	15	12	2	7	2	7	6	4	3	1	10	7	2	2	3	2	10	7·0
10	4	3	7	16	9	19	7	3	4	3	5	12	3	2	11	14	0	6	3	2	5	3	5	2	6	10	0	2	3	3	5	6·5
11	2	4	3	8	19	8	19	3	4	2	3	12	3	2	11	14	0	6	3	2	5	3	5	2	6	10	0	2	3	3	5	5·9
12																																
Total Daily Movement.	269	162	121	218	394	431	480	342	197	159	138	151	272	148	65	242	256	194	182	66	92	171	115	104	332	274	190	100	140	93	193	8·5

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1863.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Sept. 1	29·964	55·0	49·4	·83	·366	61·4	45·1	16·3	10, 10, 10	N, NNE, NE by N.	·000
„ 2	29·709	59·1	52·5	·80	·406	67·4	53·8	13·6	4, 6, 7	SW by W, SW, SW.	·050
„ 3	29·629	54·3	44·3	·71	·307	61·4	50·0	11·4	4, 7, 2	SSW, SW, W.	·238
„ 4	29·785	55·2	47·9	·78	·347	63·9	42·1	21·8	2, 8, 10	SW, WNW, WNW.	·016
„ 5	29·831	54·8	49·7	·84	·369	63·5	43·1	20·4	3, 9, 9	NNE, NE by E, —.	·000
„ 6	29·948	56·6	50·7	·82	·382	64·2	49·5	14·7	1, 10, 9	W by N, W, SSW.	·008
„ 7	...	...	...	...	...	67·7	50·7	17·0	...	...	·000
„ 8	30·082	61·2	57·1	·87	·475	68·5	48·0	20·5	10, 10, 9	SSW, WSW, SW.	·006
„ 9	30·026	60·7	54·8	·82	·439	68·0	54·8	13·2	10, 9, 9	W by N, SW, SW by S.	·003
„ 10	29·950	53·5	46·9	·80	·336	60·7	53·9	6·8	10, 3, 1	N, N by W, NNE.	·219
„ 11	30·104	53·6	43·3	·70	·296	62·4	40·1	22·3	1, 9, 9	NW, W by N, W by N.	·000
„ 12	30·152	55·9	50·2	·82	·376	64·5	39·2	25·3	2, 4, 9	SSW, SW by W, SSW.	·008
„ 13	29·888	58·0	51·8	·81	·397	66·4	54·2	12·2	10, 5, 10	SSW, SW by S, SW by S.	·003
„ 14	...	...	...	...	...	63·9	56·1	7·8	...	...	·015
„ 15	29·974	62.2	53·8	·76	·425	69·9	54·8	15·1	3, 3, 7	NE, ENE, NE by N.	·153
„ 16	30·211	56·8	48·6	·76	·356	64·5	53·9	10·6	10, 3, 10	NNE, NNE, NE.	·007
„ 17	30·359	55·0	47·4	.77	·341	61·4	47·6	13·8	10, 9, 10	NE, NE, NNE.	·000
„ 18	30·376	57·2	49·7	·78	·369	64·4	43·3	21·1	3, 0, 2	NNE, NNE, NE by N.	·000
„ 19	30·320	61·0	46·9	·62	·336	67·3	50·9	16·4	4, 0, 0	ENE, E by N, ENE,	·000
„ 20	30·207	59·7	48·3	·68	·352	67·0	51·3	15·7	3, 0, 1	N, E, NE by E.	·000
„ 21	...	...	...	...	...	59·4	54·9	4·5	...	...	.004
„ 22	30·119	52·4	42·0	·70	·283	57·5	51·3	6·2	10, 10, 9	NE by E, E by N, E.	·000
„ 23	30·055	54·9	46·0	·74	·325	62·1	37·3	24·8	7, 9, 7	E by S, E by S, E.	.000
„ 24	29·866	56·4	52·0	·86	·400	63·2	48·0	15·2	9, 10, 10	E, E by S. ENE.	·003
„ 25	29·890	58·1	54·6	·89	·436	65·5	51·4	14·1	10, 10, 5	SW by W, W by S, SW by W.	·110
„ 26	29·895	58·7	56·5	·93	·465	66·9	49·9	17·0	9, 10, 6	S by E, SW by S, SSW.	·010
„ 27	29·877	59·3	58·2	·97	·492	67·1	54·0	13·1	9, 9, 9	E by S, E, E.	·030
„ 28	...	...	...	...	...	65·9	55·4	10·5	...	...	·020
„ 29	29·772	58·9	59·4	1·00	·513	66·0	56·7	9·3	10, 10, 10	SE by E, SSE, SSE.	1·359
„ 30	29·850	56·2	52·3	·88	·404	65·8	54·1	11·7	4, 7, 10	SW by S, SW, SW.	·335
Monthly Means.	29·994	57·1	50·5	·81	·384			14·7			2·597

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—SEPT. 1862.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Mean.
Hour. 12 1																															
1 2																															
2 3																															
3 4																															
4 5																															
5 6																															
6 7																															
7 8																															
8 9																															
9 10																															
10 11																															
11 12																															
A. M. 12 1	2	5	13	3	2	3	5	3	3	5	2	2	9	13	8	10	7	3	4	10	14	14	3	5	5	2	3	1	10	5·7	
2 3	6	5	14	2	2	4	6	2	5	5	3	3	8	8	12	12	9	1	13	15	13	15	4	6	6	1	2	2	2	6·1	
3 4	4	4	15	1	1	3	4	2	3	4	3	1	6	7	11	11	9	1	11	13	12	12	2	3	7	1	1	2	5	5·3	
4 5	5	5	16	1	3	3	2	3	3	3	1	1	8	10	11	11	9	1	11	12	11	12	2	2	7	1	2	2	10	5·7	
5 6	7	6	18	2	1	3	7	4	5	10	4	2	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	14	5·9	
6 7	8	7	19	2	3	3	7	5	6	10	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	12	5·9	
7 8	8	8	21	3	3	3	8	6	7	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	12	6·3	
8 9	9	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
9 10	10	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
10 11	11	10	21	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
11 12	12	10	21	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
P. M. 1 2	1	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
2 3	2	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
3 4	3	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
4 5	4	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
5 6	5	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
6 7	6	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
7 8	7	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
8 9	8	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
9 10	9	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
10 11	10	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
11 12	11	9	22	3	5	3	8	6	8	11	4	3	13	12	13	12	9	0	11	13	11	12	2	4	7	1	1	2	13	6·3	
Total Daily Movement.	199	163	358	80	94	84	121	116	134	168	93	166	296	189	254	333	298	158	353	414	362	333	171	289	128	181	96	99	116	301	8·5

MICROSCOPIC WRITING, ENGRAVING AND PRINTING.

In our September number (page 143), we gave an account of Mr. Webb's ingenious instrument for microscopic writing. The principle as then explained appears to be substantially the same as that of Mr. Peters's Microscopic Pentagraph; and the results obtained by it are equally worthy of remark. At the date of our last notice Mr. Webb only exhibited specimens of minute writing on glass, but he has recently introduced a very elegant novelty in the shape of microscopic engraving and printing from copper-plates. In this manner he has produced highly-finished copies of the Lord's Prayer, the Apostles' Creed, God Save the Queen, Rule Britannia, and sixteen lines of verse on the International Exhibition. Many visitors have engraved their own address cards, by writing their names with a pencil on paper, and leaving the instrument to diminish and transmit the motion to the diamond point by which the letters were inscribed on a small copper plate.

To print from these delicate plates requires peculiar care and skill, but all the difficulties have been ably surmounted by Mr. Fautley, who has been working in conjunction with Mr. Webb, and the microscopic engraving, although scarcely visible to the naked eye, as a faint stain upon the paper, comes out with beautiful distinctness and regularity when placed on the stage of the microscope, and viewed with an inch or two-thirds object-glass. If the famous wizard Merlin should return to earth, and desire to print his magic book, Mr. Webb and his colleague would be able to reproduce the pages with "ample marge;"

> "And every marge enclosing in the midst
> A square of text that looks a little blot;
> The text no larger than the limbs of fleas."

They could indeed supply a diminished copy, as our readers will see when they receive the specimen we have had engraved for their delectation,* and in which the letters are considerably less than the size indicated by the poet's zoological comparison. That this is no exaggeration they may learn by micrometrical measurement, which Mr. Webb assures us will show that some of the letters only measure the half-millionth of an inch!

Mr. Webb has shown us some blocks of glass nearly inch cubes, on which he had engraved microscopically, and from

* A beautiful specimen of the engraving will be forwarded to readers who will send a directed envelope enclosing two postage stamps to Messrs. Groombridge and Sons, 5, Paternoster Row.

which he had printed specimens, using blacklead instead of ink. He also explained the difficulty in finding an ink that would deliver itself from such exceedingly minute cuttings on copper, but his present process is so successful that he has printed the Lord's Prayer from a copper-plate in a space not exceeding one-thousandth of an inch.

DOUBLE STARS—OCCULTATIONS.

BY THE REV. T. W. WEBB, F.R.A.S.

THE unforeseen arrival of the comet, now on its way into the depths of space, occasioned an interruption in our list of double stars, which we shall now resume; and in preparing work for the lengthening evenings, let us indulge the hope that the weather may prove more propitious than has generally been the case during the past season. Some of our readers may perhaps have been expecting an earlier notice of several beautiful pairs; but we have not been desirous of subjecting them needlessly to that neck-twisting which is the inseparable nuisance of the achromatic in amateur hands, and the comfort of viewing them at a lower altitude will be a sufficient explanation of the postponement. We bring forward, then, at last, the brilliant gem which has so long adorned the neighbourhood of our Zenith—

46. *α Lyræ*, *Wega*, or *Vega*, sometimes less accurately denominated *Lyra*. 43″·4. 135°·2. 1 and 11. Pale sapphire and smalt-blue. Optically double. The great star is a most splendid and lovely object in the telescope; not dissimilar in the quality of its light to Sirius, though inferior in brilliancy. It seems, however, hardly possible that Wollaston can have done it justice, in assigning to it only one-ninth of the light of Sirius: nine *Wegæ* compacted into one would surely far outvie any star in the firmament. But independently of this estimate, its brightness has been diversely rated. The result of its comparison with Arcturus has already been given in the INTELLECTUAL OBSERVER, No. VI. p. 435. The elder Herschel, in 1806, gave, as comparative places in the scale of magnitude, Capella 1·25; Lyra 1·30; Procyon 1·40. His son, in his *Outlines of Astronomy*, ranks Capella, Lyra, and Procyon all of equal magnitude; but in his *Results of Observations at the Cape*, in 1847, says—"within my own distinct recollection I always considered Capella inferior to Lyra, whereas it is now decidedly superior." On the contrary, Laugier, with Arago's apparatus, found the quantity of light from Wega 617, that from Procyon 445; and Seidel, with Steinheil's photometer, found for these

stars 100 and 71 (a result very nearly agreeing with Laugier's), Arcturus and Capella standing at 84 and 83 of the same scale. We seem to be here reduced to the conclusion that either the methods hitherto employed of investigating relative brightness are worthy of little confidence, or the results are vitiated by variation of light. Difference of colour, as referred to in our p. 435, may not be without its influence, and possibly other unknown peculiarities may be concerned, since Humboldt has remarked that from some such cause Wega scintillates less than Arcturus and Procyon. From the probability that so splendid an object must be within measurable distance from our eyes, the attention of observers has been much directed to its parallax, but with no great success. W. Struve's later observations gave its amount 0″·2613, inferring a distance 771,400 times greater than that of the Sun; so that if our solar distance were represented by 1 foot, that of Wega would be 146 miles; and its light would take 12 years in reaching us. Peters, however, finds less than half this parallax; Otto Struve, combining both, prefers 0″·1549, widening in proportion that already amazing interval; while Airy considers all these results as problematical, and the parallax so small—that is, the distance so enormous,—as to be unmeasurable by our present instruments. With these data before him, who can view that glorious object without the impression that he is gazing upon a sun far greater in dimensions, or at any rate in splendour, than our own, and bearing a yet more impressive testimony to the majesty of its Creator? Wega is so situated, that in consequence of that slow motion called "the precession of the equinoxes"—the result of the attraction of the Sun and Moon upon our protuberant equator—by which the axis of the Earth is continually changing its position with respect to the stars, it might ultimately take the place of the Pole Star, but only after β and *a Cephei* and δ *Cygni* had successively gained and relinquished that distinction; and after a *computed* period of 12,000 years.

Thirty-five companions to *Wega* have been counted (of course with some low power) in the field of the great achromatic, of 14·95 inches aperture, at Harvard University, Cambridge, United States. Of these one is much closer than the rest, and we must now try to find it; but if we succeed, we shall only perceive a very minute speck, barely distinguishable so near the vivid blaze of its overpowering neighbour. Yet who shall say what, in its uncomputed and incalculable and incomprehensible distance, may be the intrinsic splendour and magnitude of that minute speck, so insignificant in our eyes; upon any estimate, doubtless very far exceeding the bulk of our eight-thousand-mile globe? Independently, however, of this consideration, which is common to it with hundreds and

thousands of similar objects, it possesses some interest both as the point of departure from which the parallax of the great star is measured, and as a well-known test for instruments of a moderate size. It is evident that a certain proportion of light is requisite. I believe it might be seen with $3\frac{1}{2}$ inches of real excellence. I have caught it, but only in very fine weather, with $3\frac{7}{10}$; four inches ought to hold it pretty steadily in a clear atmosphere. Increase of power is serviceable, as tending to draw away that little point from the dazzling blaze, and to place it on a quieter and darker background; and thus Sir W. Herschel found it invisible with 227, but visible with the same aperture with 460; and when Kitchener could not see it in his 5-feet achromatic with 250, he perceived it easily with 350 and 450. In my present instrument I see it with 55. What must be the light-grasping capacity of Sir John Herschel's $18\frac{1}{4}$-inch speculum we may guess from his statement, that he has well seen and measured it in broad twilight, just after sunset, and with a moon!

The next star to *Wega* (at the present season above it) is a peculiarly beautiful and remarkable object, commonly called ϵ *Lyræ*, though more correctly by a combination of Bayer's alphabetical with Flamsteed's numerical designation—

47. $\epsilon^1 4$ and $\epsilon^2 5$ *Lyræ*. This is a quadruple, or more properly a double-double star. First of all we have a pair 3′ 27″ apart, just far enough to be separately distinguished by a very keen sight. Herschel I. once mentions having so seen it; Bessel could divide it at thirteen years of age, and I have met with two modern instances in England; but to the generality of eyes it will probably appear (as it does to my own) what Smyth calls it, "an irregular looking star." This pair, of course, is widely separated in the telescope, while at the same time it is perceived that each of the components is again closely double—a beautiful combination. The data of ϵ^1 are 3″·2, 20°·6, 5 and $6\frac{1}{2}$, yellow and ruddy: those of ϵ^2 are 2″·6, 150°·9, 5 and $5\frac{1}{2}$, both white. Each pair is believed to be in slow motion, ϵ^1 the most northerly, with a period of about 2000 years, the other as fast again: while both may possibly revolve round a common centre of gravity in years innumerable by the skill of man. Struve differs from other observers (except Dembowski) in ascribing a bluish tint to the smaller star of ϵ^1; this peculiarity attaches to the observations of five years, and is the more remarkable as the colours of this great astronomer are usually accordant with those of other standard authorities. He also suspects variable light in one of the stars of ϵ^2. An aperture of $2\frac{1}{4}$ inches, perhaps even a little less, is sufficient, if really good, for these beautiful pairs. With large instruments three more stars are added to the group; one, which Dawes calls 9·5 mag. is comparatively

XUM

obvious; two others, between the principal pairs, 45″ apart, the "debilissima" couple of Sir J. Herschel, though both rated 13 mag. are considerably unequal, and form an admirable test for light. With $3\frac{7}{10}$ inches I had pretty certain glimpses of the one and occasional suspicions of the other; with $5\frac{1}{2}$ both are easily seen.

Just to the left of *Wega* we shall observe two small stars almost in a line with it. The nearest of these is—

48. ζ *Lyræ*. 43″·8. 149°·6. 5 and $5\frac{1}{2}$. Topaz and greenish. This is a noble though wide object; but merely optical. 1850·77 and 1855·68, with $3\frac{7}{10}$ inches, I thought the smaller star 7 and 6 mag. It now appears as in Smyth.

The further of the two is—

49. δ^1 and δ^2 *Lyræ*. Bluish and fine orange, with many companions. This pair is not in the Bedford Catalogue, but forms a very noble object under a low power.

A little below these two small stars, but somewhat more to the left, we find two more similarly arranged on a parallel line, but brighter, being of 3 mag. We must turn the telescope on the one to the right, which is—

50. β *Lyræ*, a *quadruple* group. 45″·8. 60″. 71″. 150°·1. 319°·5. 25°. 3, 8, $8\frac{1}{2}$, and 9. Very white and splendid, pale grey, faint yellow, and light lilac; with a minute pair *s*. The large star is a marvellous object, from its variation of light. This, according to Argelander, takes place in 12d. 21h. 53m. 10s., but with two maxima and minima during that period, each maximum reaching the same point between 3 and 4 mag., the minima being unequal, alternately above and below 4 mag. The duration of these singular changes has also been found variable, increasing from the year 1784, when it was discovered by Goodricke, to 1840, and subsequently slowly decreasing; a wonderful but by no means exceptional instance, which probably indicates the existence of some unknown general law. A question may perhaps be entertained, as to a possible variation in the colour of this curiously mutable star. Smyth, who gives it as above for the epoch 1834·73, states the hue of γ, the 3 mag. star to the left of it, to be "bright yellow" (1834·59). I found with $3\frac{7}{10}$ inches γ always (1849·77, 1850·47, 1850·51, 1850·7) much less yellow than β, if not white. 1862·77, with $5\frac{1}{2}$ inches, I found γ the paler in tint, though the difference was not considerable. Schmidt thought the colours always nearly the same, yellowish-white, from 1844 to 1855. Herschel and South made β white. The possibility of a variation in the brightness of γ also has been mentioned by Smyth; and there seems nothing unlikely in the idea, which at any rate deserves consideration, that change of magnitude may be, in some cases, attended by change of hue.

51. *η Lyræ*. 28″·3. 84°·8. 5 and 9. Sky-blue and violet (1834·74). I found the large star yellow, 1849·76 and 1850·77, with $3\frac{7}{10}$ inches; and 1849·93, with Mr. Bishop's 7-inch achromatic in the Regent's Park: pale yellow, 1862·77, with many powers of $5\frac{1}{2}$ inches. On the other hand, Struve makes it *cærulea* during 5 years, about 1830. It lies in a beautiful field, containing a pretty open 8 mag. pair *s p*, and a smaller open pair, 10 and 11 mag. *f* a little *n*. To find it let a line joining *Wega* and *γ* be taken as one side of an equilateral triangle—the opposite angle to the left will fall near two small stars, the uppermost of which is *η*; or *η* is about one-third of the distance from *Wega* to *γ* Cygni—

The two stars *β* and *γ Lyræ* point at some distance *s f*, on to the left, a little above a glorious object.

52. *β Cygni. Albireo*, in the beak of the swan. 34″·4. 55°·6. 3 and 7 (perhaps, Smyth says, underrated). Golden-yellow and smalt-blue; merely, as it seems, in optical juxtaposition, though one of the most splendid and beautiful as well as best-known pairs in the heavens. Any telescope, fit to be turned upon the stars at all, will show it, though of course it will gain greatly with increase of light and power.

We will now examine some interesting objects in the head of the long winding constellation *Draco*, many folds of which lie between *Wega* and the further part of *Ursa Major*.

A line from *β Lyræ* through *Wega* falls at some little distance upon a 2nd mag. star in the Dragon's head, *γ Draconis*, or *Ras al Tannin*, worth looking at for its fine deep yellow hue, but more remarkable as passing almost exactly through the zenith of Greenwich, in consequence of which Bradley, in observing it vainly for a parallax which his instrument could not detect, was led, in 1728, to the discovery of the aberration of light. A similar line from *γ Lyræ* through *Wega* falls upon another 2nd mag. star in the head, *β Draconis*, or *Alwaid*, almost exactly *n* of which, at a short distance, lies—

53. *ν*[1] and *ν*[2] *Draconis*. 61″·9. 311°·8. Both 5, and pale grey. A bright pair, suitable for a small telescope, which seems to have a proper common motion.

As far from *ν*, *p*, as *β* is from *γ*, we get our next object—

54. *μ Draconis*. 3″·6. 206°·7 (1830·79). 3″·3. 200°·3 (1839·53). 4 and $4\frac{1}{2}$. White and pale white. This beautiful double star is undoubtedly binary, with a period, Smyth thinks, of about 600 years. Two inches of aperture, he found, would show it. Secchi's measures give, for 1857·5, 2″·746 and 188°·37, so that its progressive motion is striking.

Two lines, through *γ* and *β*, and through *ν* and *μ*, converge a little beyond—

55. 17 *Draconis*. 2″·8. 115°·7. 6 and $6\frac{1}{2}$ Pale yellow and

faint lilac; converted into a fine triple group by the juxtaposition of another white 6 mag. star (16 *Draconis*), at 90″·5 and 194°·6. These are, as yet, said to be stationary.

A little *n f ν*, that is, above it at the present season, and forming the N. point of a triangle, of which *γ* and *β* are the base, is *ξ*, a 3 mag. star. A line through *ν* and *ξ* soon falls upon—

56. 39 *Draconis*. 3″·3. 5°·5. 5 and 8½. Pale white and light blue; a 7 mag. ruddy companion stands at 89″·2 and 21°·7. There is a suspicion of binarity here; but Secchi remarks, as Struve had done, the discordancy of measures in so distinct an object.

The previous line through *ν* and *ξ* continued through the last pair, will show us, if bent a little to the left,—

57. *o Draconis*. 30″·4. 347°·6 (1830·78). 30″·3. 345°·5 (1837·89). 5 and 9. Orange and lilac. This beautiful pair, if physically connected, as Smyth thought probable, is a striking exemplification of the fact already referred to, that the magnitude of stars is no criterion of their distance.

We now leave the accumulation of double stars so curiously clustered together about the head and neck of *Draco*, and return to *Cygnus*. We have already taken *Albireo* (No. 52) on the beak. The rest of the constellation, when on the meridian, lies N. and W. of this point. In following the galaxy from *Albireo* towards *Cassiopea*, we soon find it crossed by a somewhat bent line of three nearly equidistant 3 mag. stars (besides a fourth to the left). These are *δ*, next the head of *Draco*, *γ* in the centre, and *ε*. A little above *γ* we come to *α*, *Al Ridph*, the *lucida* of the constellation; a star whose entire inaccessibility to the ordinary questioning of parallax, and absence of proper motion, indicate a distance perfectly incomprehensible; as its brilliancy under such circumstances exalts it, not improbably, to the dignity of being one of the largest bodies in the universe. If we now suppose a line from *α* to *δ*, a little outside (or N.) of it, we shall find—

58. *o*² *Cygni*, an orange 4 mag. star, which with *o*¹, 5½ mag. cerulean blue, at 5′ 38″, and 63P.XX. 7½ mag., of the same colour, at 1′ 46″·6, forms a fine bright group, in one of the glorious fields so continually occurring in galaxy regions. A 16 mag. companion, 15″ from *o*², is not likely to fall under the notice of any observer with less than 6 inches of aperture.

59. *χ Cygni*. 25″·7. 72°·9. 5 and 9. Golden-yellow and pale blue. This pair is relatively fixed, but has probably a common proper motion. It will be found less than half way (about two-fifths) from *β* to *γ*, a little to the right.

A line carried from *γ* through *o* (No. 56) nearly as far again, will pass a little above a very pretty, though not easy object—

60. ψ *Cygni*. 3″·5. 184°·2. 5½ and 8. Bright white and lilac.

OCCULTATIONS.

There will be three occultations at convenient hours during the present month. The earliest will be a fine one, well worth looking for. Nov. 6. δ Arietis, 4½ mag., will disappear (at Greenwich) at 10h. 6m., and reappear at 11h. 22m. 24th, a 6 mag. star, No. 6539 B. A. C. (*i. e.* of the British Association Catalogue) will be covered by the moon's limb at 6h. 31m., and come forth at 7h. 4m. 30th, 45 Piscium, 6 mag., will be occulted from 7h. 21m. till 8h. 22m.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE Thirty-second Annual Meeting of the British Association was held this season at Cambridge, under the presidency of Professor Willis, who delivered the inaugural address, which was chiefly devoted to the details of the Society's expenditure. In the lecture devoted to Intellectual and Physical Science, Mr. J. Nasmyth described "The Features of the Sun's Surface," as at present known. The spots he regarded as gaps or holes in the luminous surface of the sun, exposing the dark nucleus, and over this appears a thin, gauze-like veil, then comes the penumbral stratum, and over all the luminous stratum, which he had discovered to consist of lenticular or willow-leaf shaped masses, crossing each other in every direction, so as to hide the dark nucleus, except at the spots. These objects were found to be in constant motion, shooting over the whole surface. Some of them were as large as the surface of the whole earth.

The Rev. Dr. Pritchard regarded the discovery as one of very high importance in the knowledge of the physical constitution of the sun.

In connection with this subject, Professor Selwyn showed several "autographs of the sun," taken with his "heliautograph," which consists of a camera and instantaneous slide, attached to a refractor of 2¾ inches aperture, the principle being the same as that of the "photoheliograph" made for the Kew Observatory. Two of the autographs taken have the edge of the sun in the centre of the photographic plate, showing that the diminution of light towards the edges of the disc is a real phenomenon, and not wholly due to

the camera. In two taken on the 4th of August, the great spot (20,000 miles in diameter) appears on the edge, and a very distinct notch is seen, giving evidence that the spots are cavities; but observations and measurements tend to show that this evidence is not conclusive, for there was still a remaining portion of photosphere between the spot and the edge. The phenomena shown in these autographs appear to confirm the views of Sir J. Herschel, that the two parallel regions of the sun where the spots appear, are like the tropical regions of the earth, where tornadoes and cyclones occur. The faculæ seem to show that the tropical regions of the sun are highly agitated, and that immense waves of luminous matter are thrown up, between which appear the dark cavities of the spots, whose sloping sides are seen in the penumbræ. Other analogies between solar spots and earthly storms were pointed out, and reference was made to the glimpses of the structure of the sun exhibited by Mr. Nasmyth as confirming the above views.

One of the most important and popular papers read before the Association was that of Mr. Glaisher on his recent BALLOON ASCENTS. Mr. Glaisher stated, that the first ascent was from Wolverhampton on July 17. Owing to the force of the wind, considerable difficulty was experienced in the preliminary arrangements. The ascent took place at 9·43 A.M., and at once the balloon was quiescent. The swaying to and fro had ceased in an instant, and I at once proceeded to fix the instruments. At the height of 4000 feet we entered a stratum of clouds of nearly a mile in thickness. A height of more than 10,000 feet had been passed before I could put all the instruments in working order. The sky was of a deep Prussian-blue colour, without a cloud of any kind upon its surface. At starting, the temperature of the air was 59°; at 4000 feet, 45°; and descended to 26° at 10,000 feet; and then there was no variation of temperature between this height and 13,000 feet. During the time of passing through this space, Mr. Coxwell and myself both put on additional clothing, feeling certain that we should experience a temperature below zero before we reached an altitude of five miles; but, to my surprise, at the height of 14,500 feet, the temperature, as shown by all the sensitive instruments, was 31°; and at each successive reading, up to 19,500 feet, the temperature increased, and was here 43°. When we had fallen somewhat, the temperature again began to decrease with extraordinary rapidity, and was 16°, or 27° less than it was twenty-six minutes before. At this time—about eleven A.M.—we were at a height of five miles, when we began to descend. Immediately afterwards we entered a dense cloud, which proved to be no less than 8000 feet thick, and in passing through which the balloon was invisible from the car.

The most important ascent took place from Wolverhampton on the 5th of September. It commenced at 1·3 P.M.; the temperature of the air was 59°; at the height of one mile it was 39°, and shortly afterwards we entered a cloud of about 1100 feet in thickness, in which the temperature fell to 36½°, and the air was saturated with moisture. We reached two miles in height at 1·21, three miles at 1·28, and four miles at 1·39. In ten minutes more

we had reached the fifth mile, and the temperature had passed below zero, and then read minus 2°. Up to this time I had experienced no difficulty in breathing, whilst Mr. Coxwell, in consequence of the necessary exertions he had to make, had breathed with difficulty for some time. Mr. Coxwell ascended into the ring, and I endeavoured to reach some brandy which was lying on the table at a distance of about a foot from my hand, but I was unable to do so. My sight became dim. I looked at the barometer, and saw it between 10 and 11 inches, and tried to record it, but was unable to write. I then saw it at 10 inches, still decreasing fast, and just managed to note it in my book; its true reading, therefore, was about $9\frac{3}{4}$ inches, implying a height of about 29,000 feet. I was losing all power, and endeavoured to rouse myself by struggling and shaking. I essayed to tell Mr. Coxwell I was becoming insensible, but I had lost the power of speech. I saw Mr. Coxwell dimly in the ring; it became more misty, and finally dark. I was still conscious, and knew I should soon be insensible, and I suddenly sank as in sleep. On recovering consciousness, I heard Mr. Coxwell say, "What is the temperature? Take an observation, now, try." I could neither see, move, nor speak, but I knew he was in the car trying to rouse me. I then heard him speak more emphatically, "Take an observation. Now *do* try." I then saw the instruments dimly, and Mr. Coxwell very dimly, then more clearly, and shortly afterwards said to Coxwell, "I have been insensible;" and he replied, "You have; and I nearly." I recovered somewhat quickly, and Mr. Coxwell said, I have lost the use of my hands; give me some brandy to bathe them. His hands were nearly black. I saw the temperature was still below zero, and the barometer reading 11 inches, and increasing quickly. I resumed my observations at 2·7, recording the barometer reading 11·53 inches, and the temperature minus 2°. I then found that the water in the vessel supplying the wet-bulb thermometer, which I had by frequent disturbance kept from freezing, was one mass of ice. Mr. Coxwell then told me that whilst in the ring he felt it piercingly cold; that hoar frost was all round the neck of the balloon; and on attempting to leave the ring he found his hands frozen, and he had to place his arms on the ring and drop down; that he found me motionless, with a quiet and placid expression on the countenance; that he at first thought I was resting myself; that he then spoke to me without eliciting a reply, and then observed my arms hanging by my side, and my legs extended, and found I was insensible. He then felt that insensibility was coming over himself, and that he could not assist me in any way; that he became anxious to open the valve; that his hands failed him; and that he instantly seized the line between his teeth and pulled the valve open two or three times, until the baloon took a decided turn downwards. Some pigeons were taken up. One was thrown out at the height of three miles; it extended its wings and dropped like a piece of paper. A second, at four miles, flew vigorously round and round, apparently taking a dip each time. A third was thrown out between four and five miles, and it fell downwards. A

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fourth was thrown out at five miles, and it fell downwards. A fifth was thrown out at four miles when descending; it flew in a circle, and shortly alighted on the balloon. The two remaining pigeons were brought down to the ground. One was found dead, and the other, a carrier, had attached to its neck a note. It would not, however, leave, and when cast off the finger returned to the hand. After a quarter of an hour it began to peck a piece of ribbon by which its neck was encircled, and it was then jerked off the finger, and it flew with some vigour finally towards Wolverhampton. One of the carriers returned to Wolverhampton on Sunday, and this is the only one we heard of.*

These ascents have led me to conclude, firstly, that it was necessary to employ a balloon containing nearly 90,000 cubic feet of gas, and that it was impossible to get so high as six miles, even with a balloon of this magnitude, unless carburetted hydrogen varying in specific gravity from ·370 to ·340 had been supplied for the purpose.† The amount of ballast taken up affords another clue to the power of reaching great heights. Gay-Lussac's ballast was reduced to 33lbs. Rush and Green, when their barometers, as stated by them, stood at 11, had only 70lbs. left, and this was considered a sufficient *playing* power. We found that it was desirable to reserve 500lbs. or 600lbs.; as it was evident that a large amount of ballast was indispensable to regulate the descent. Secondly, it was manifest throughout our various journeys that excessive altitude and extended range as to distance are quite incompatible. The too readily-accepted theory as to the prevalence of a settled west or north-west wind, was not confirmed in our trips. Nor was the appearance of the upper surface of the clouds such as to establish the theory that the clouds assume a counterpart of the earth's surface below, and rise or fall like hills or dales. The formation of vapour along the course and sinuosities of the river, during an ascent from the Crystal Palace, was a very remarkable demonstration. The principal conclusions deduced from these observations may be briefly stated: that the temperature of the air does not decrease uniformly with the height above the earth's surface, and that, consequently, more elucidation upon this point is required, particularly in its influence on the law of refraction. That an aneroid barometer can be made to read correctly certainly to the first place, and probably to the second place of decimals, to a pressure so low as five inches. That the humidity of the atmosphere does decrease with the height with a wonderful increasing ratio, till at heights exceeding five miles the amount of aqueous vapour in the atmosphere is very small indeed. That observations up to three

* It is evident, from this description, that Mr. Glashier was supplied with the heavy, tame variety of pigeon, known as the English carrier, which is dull of flight and does not possess the faculty of returning from long distances. Moreover, Mr. Glashier must have been very badly advised, to place ribbons round the birds, which would severely impede the flight even of those quick flying Belgian "Smerles," whose rate of speed enables them to pass an express train as if it were a stationary object.—W. B. T.

† The average specific gravity of ordinary coal gas is ·500. The gas employed by Mr. Glaisher was specially made for these ascents, being highly heated, so as to obtain a low specific gravity.—W. B. T.

miles high, even of a delicate nature, can be made as completely in the balloon as on the earth; that at heights exceeding four miles they cannot be made quite so well, because of the personal distress of the observer; that at five miles high it requires the exercise of a strong will to make them at all; that up to three miles high any person may go into the car of a balloon who has any ordinary degree of self-possession; that no one with heart disease or pulmonary complaints should attempt four miles high.

NOTES AND MEMORANDA.

THE DISTORTED SKULLS OF WROXETER.—Dr. Henry Johnson, of Shrewsbury, communicates to the Royal Society an explanation of the deformity exhibited by nine and twenty skulls discovered at Wroxeter. He ascertained that the soil in which they were found was acid, and then made an experiment by keeping a piece of fresh bone for a month in water impregnated with carbonic acid, which was found to be flexible at the end of that time. He therefore concludes that the deformity of the skulls was not congenital, but posthumous, and occasioned by a softening of the bones soon after interment, and the pressure of the superincumbent soil. After the animal matter of a bone has disappeared, it would break, not bend.

THE PHOTOGRAPHIC TRANSPARENCY OF BODIES.—Professor W. Allen Miller has laid before the Royal Society a valuable paper on this and an allied subject, "The Photographic Effects of Metallic Spectra, obtained by means of the Electric Spark." He finds that "colourless bodies which are equally transparent to the visible rays, vary greatly in permeability to the chemical rays;" that "bodies which are photographically transparent in the solid form preserve their transparency in the liquid and in the gaseous states," and that colourless transparent solids, which exert a considerable photographic absorption, preserve their absorptive action with greater or less intensity, both in the liquid and gaseous states." Glass vessels could not be employed in these experiments, "as they all, even in thin layers, shorten the spectrum by from three-fifths to four-fifths, or even more, of its length." Rock crystal, cut in thin slices and polished, was the only substance the Professor found he could use with advantage. After atmospheric air and certain gases, rock crystal, ice, pure water, and fluor spar are most perfectly diactinic, and rock salt is scarcely, if at all, inferior to them. Among the salts of inorganic acids, the nitrates are the most remarkable for their power of arresting the chemical rays. Most liquids, except water, arrest more or less of their rays, and they are stopped by trichloride and oxychloride of phosphorus, although perfectly transparent and limpid. Reflection from a metallic speculum caused a great loss of actinic power.

THE LONG SPECTRUM OF ELECTRIC LIGHT.—In 1853 Professor Stokes exhibited this spectrum at the Royal Institution, using electric light. He had previously found that glass was opaque for the more refrangible and invisible rays of the solar spectrum, and that electric light contained rays of still higher refrangibility. Rejecting the glass, and using a prism and lens of quartz, he obtained a spectrum which, when thrown upon a highly fluorescent substance, was found to be six or eight times as long as the ordinary spectrum. He has recently laid further researches before the Royal Society, and among the metals he has examined he finds aluminium capable of producing the largest number of rays of extreme refrangibility. With some metals, broad and lightly convex electrodes exhibited the invisible lines better than wires, and the Professor adds: "The blue negative light formed when the jar is removed, and the electrodes are close together, was found to be exceedingly rich in invisible rays, especially invisible rays of moderate

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refrangibility. These exhibited lines independent of the electrodes, and therefore referable to the air."

IMMENSE CASTING.—A mass of iron for a pile hammer has just been cast at the Usines de l'Horme, near St. Chamond, that weighs 38,000 kilogrammes; 1 kilogramme is equal to 2·670 lbs. avoirdupois. It will be transported to Rive-de-Gier, on a truck drawn by eighty-eight oxen, harnessed in fours, and led by twenty-two waggoners.—*Cosmos.*

VARIABLE NEBULÆ.—M. D'Arrest announces that two other nebulæ in Taurus, only eight or nine degrees from that of Mr. Hind, exhibit indubitable variability. The first is that discovered by M. Tempel at Venice on the 19th October, 1859. It had 3h. 37m. 7s. R.A., and 23° 23′ D. This nebula of the Pleiades was described by M. Tempel as easily visible. In December, 1860, MM. Peters and Pope saw it with difficulty through the equatorial at Altona. In August, 1862, M. D'Arrest could no longer see it with the powerful telescope at Copenhagen. The second of the nebulæ in question is one of those observed at Bonn, and afterwards on the 5th February, 1859, by Mr. Tuttle, at Cambridge. Now it is almost invisible. These three nebulæ are the only ones, according to M. D'Arrest, whose variability is beyond doubt.—*Cosmos.*

NEW GUNPOWDER.—M. Schultz, a Prussian captain of artillery, has invented a new powder, used for the first time at the Frankfort rifle meeting. It is said to be cheaper, lighter, and more effective than the common sort, and to leave the barrel quite clean after thirty discharges. It is in brownish-yellow grains, like wood saw-dust. Its composition is not stated. The Austrians are reported to be successful in the employment of gun cotton for artillery.

CLOSING FRUIT JARS.—The *Homestead* recommends instead of corks, tying the mouths of the jars, while still hot, with strips of cloth, saturated with equal parts of beeswax, resin, and tallow. The superfluous cloth should be cut off, and then dipped in melted wax, with half its weight of tallow.

AN AMALGAM OF CADMIUM.—As most amalgams are brittle, it is remarkable, as Dr. B. Wood mentions in *Chemical News*, that equal parts of cadmium and mercury should form a tough and highly malleable composition.

ENGELMANN ON INFUSORIA.—Dr. Arlidge publishes, in *Annals of Natural History*, an abstract of researches in infusoria, by T. W. Engelmann. This observer confirms Müller's discovery of spermatozoa in *Paramecium aurelia*, and says they are not, as usually represented, thin rods equally pointed at both extremities, but have a bulky anterior, and a thinner posterior extremity of greater transparency. Their maximum length is 0·008 of a millimetre. "The embryonic development observed by Stein in *Stylonichia mytilus*, also fell under his notice. In 1859 he found specimens containing embryonic corpuscules; but it was not till the autumn of 1861 that he met with examples which illustrated a further stage in their history. These latter were individuals of medium size, and mostly contained but one large embryonic globule, placed between the two nuclei, close behind the angle of the anal aperture. Placed over it, on the central aspect of the animal, there always existed an elliptic or rounded opening, of variable size, which was the outlet for the escape of the mature ovum. On one occasion only was an elongated and rounded dorsal aperture found, in addition to the abdominal foramen just named, and serving like it for the escape of the embryos, the act of birth was several times witnessed; sometimes the embryonic globules escaped as such, at others they developed tentacles, and assumed the acinetiform figure usually described." He does not know the subsequent history of the embryos, but does not believe in their immediate transition to the ordinary form of Stylonichia, and is disposed to accept Stein's view of an alternation of generations. He rejects Balbiani's doctrine that the acinetiform beings seen to emerge from the interior of various infusoria are parasites. Many other interesting particulars will be found in Dr. Arlidge's notes.

A MICROSCOPIC VERTEBRATA.—Dr. Wallich publishes, in *Annals of Natural History*, a drawing of the jaw of a minute animal, found in mud dredged up by

him at St. Helena. It contains two rows of saw-like teeth, with four larger conical teeth in the front, arranged in two pairs; the hindmost pair being very sharp and slightly curved backwards. The extreme length of this specimen is $\frac{1}{100}$ of an inch, and he estimated the creature to which it belonged as being only $\frac{1}{30}$ of an inch long.

New Spider from Cochin China.—Dr. Albert Günther figures and describes, in *Annals of Natural History*, a spider from the above named locality, remarkable for the prolongation of its abdomen, which is "anteriorily produced into a very long, thin, cylindrical process, which is twice bent, so that its basal half is leaning backwards on the back of the abdomen, while its terminal half is directed upwards and forwards. The cephalo-thorax being united with the abdomen at no great distance from the spinners, the anterior portion of the abdomen with its appendage, is situated vertically above the thorax."

Zooteira Neligata.—Dr. T. Strethill Wright describes, in the *Quarterly Journal of Microscopic Science, New Series, No. VIII.*, this elegant creature, which he found in oyster-shells, dredged from deep water, in the Firth of Forth, near Edinburgh. He says, although the animals are not common, yet we occasionally meet with a shell completely covered with a dense forest of them, each consisting of a clear, glassy stalk, surmounted by a silvery star, and it is difficult to imagine a more gorgeous microscopic display than such an assemblage affords, especially when illuminated by oblique sunlight of various colours under low powers. [Zooteira is an actinophrys mounted on a contractile pedicle. The long hair-like appendages of the head Dr. Wright terms "palpocils," and he observes, "the animal remains for days with its palpocils sometimes stiffly extended, at other times slightly relaxed, and yielding in gentle curvatures to the currents in the water, and again at other times all thickened and clubbed at their extremities. When any small animalcule comes into contact with a palpocil, it is instantly taken prisoner, and the appendage recoils inwards with its prey to the body of the Zooteira, like a released thread of caoutchouc. In this way the whole of the body is sometimes studded with captured animalules, over which a film of endosare slowly creeps, and engulphs them."

The Genus Freya.—In the same journal, Dr. T. S. Wright states that certain protozoa, which he formerly described as *Lagotia*, must be called *Freya*, as that name was given to them in a memoir of Claparède and Lachinan, written before, but not published till after, his own paper. Dr. Wright now describes several new species, and explains how F. producta constructs its tube or cell. The adult animal (related to the Cothurnia Vaginicola, etc.) is furnished with two long curved "rotatory lobes." Its larva, which is free swimming, secretes the lower part of its cell, and fixes itself. It then builds up the long neck of the tube, carefully moulding the plastic matter with its immature lobes, which it uses as a pair of hands, just as sabella and serpula mould their tubes with their secreting leaflets. Having erected its tube to the requisite height, it finishes it off with a handsome trumpet-shaped mouth, and then retires to develop its long rotatory lobes. "The cell of this species is furnished with an immensely prolonged neck, formed of a ribbon of chitine, spirally wound in a tube, cemented by a thick internal gelatinous layer, from which it derives its green colour, and covered by a thin layer of that peculiar glutinous secretion which is used by various aquatic animals to attach themselves and their habitation to the sites where they dwell. This glutinous stuff Dr. Wright calls "colline."

New Planet.—On the 29th of August, M. Tempel discovered a new planet of 10 magnitude. M. Luther also thought he had found a new body of the same kind, but it turned out to be M. Goldsmidt's Daphne, discovered in 1856, and which has been lost sight of for six years.

The Great Comet of 1861.—*Cosmos* says that M. Sluzki, of Moscow, has computed the time of revolution of this body to be 400 years.

The Aplanatic Eyepiece.—Since our report of Mr. Burr's paper at the Astronomical Society, on the Aplanatic Eyepiece made for telescopes by Messrs. Horne and Thornthwaite, we have made several trials of one constructed on the

same principle, but of considerably higher power than that to which he referred with such strong commendation. The subject of our experiment corresponds very closely in power with a Huyghenian eyepiece, estimated at 300, with a 42-inch telescope, having a fine 3-inch Gauss objective, by Steinheil, of Munich, remarkable for the lightness of its field. It is only upon certain objects, and in very fine weather, that such an eyepiece can be fairly tried, but we have obtained a good definition of small stars, and a splendid effect upon the grand mountain scenery near the terminator of the moon before and after its full. The field is rather larger than with the Huyghenian, but the difference is not so great as in lower powers. It is also rather lighter, and on the most favourable evening of our experiments we were disposed to give it a decided preference for certain objects. From the fact of the surface of the field lens being in the focus of the eye combination, extraordinary care in freeing the former from dust is essential. It would not be fair to either the makers or our readers to say more at present, except that, as the new eyepiece is not expensive, we strongly advise astronomers to investigate its merits by actual use. Mr. Webb has employed a miscroscope object-glass for high powers, "the field lens of the ordinary construction being omitted, and the microscope object-glass taking the place of the lens next the eye." This plan works well, but it is too costly for ordinary use.

Microscopic Address Cards.—The minute cards supplied by Mr. Webb are wonderful specimens of microscopic engraving and printing. You receive a Lilliputian glazed card, without the slightest trace of any inscription. A strong pocket lens shows two faint and delicate lines, impossible to decipher: but if the little curiosity is transferred to the stage of the microscope, and examined with an inch or two-thirds objective, you at once see a name and address in elegantly-formed letters, and greatly admire the skill by which so marvellous a result is obtained.

Fish Hook Spiculæ.—We have received from Mr. Baker, of Holborn, a slide containing spiculæ of the *Hymedesmia Johnsonii* (a sponge from Madeira), and which are stated to be new objects in this country. They have the form of a double fish-hook, and on the inner surface of each hook is an extremely sharp knife edge projection, corresponding with a similar and equally sharp projection from the inside of the shank. These minute knife-blades are so arranged that, in addition to their cutting properties, they would act as barbs, obstructing the withdrawal of the hook. The two hooks attached to one shank are not in the same plane, but nearly at right angles with one another, so that when one is horizontal, the other is vertical, or nearly so. A magnification of 400 or 500 linear does not in any way detract from the sharp appearance of the knife edges, and they may take their place with the anchors of the Synapta, as curious illustrations of the occurrence in living organisms, of forms which man was apt to fancy were exclusively the products of his own contrivance and skill. We presume these hooks of the Hymedesmia answer the usual purpose of spiculæ in strengthening the soft tissue, but they must likewise render the sponge an awkward article for the Madeira sea slugs to eat.

Determining the Distance of the Sun.—M. Foucault has devised an ingenious apparatus for determining the velocity of light, and from the results thus obtained he computes the distance of the sun from the earth without leaving his study. M. Babinet in stating these facts to the French Academy, observed: "Astronomy by the measure of aberration tells us that the mean velocity of the earth round the sun is $\frac{1}{10000}$ of that of light. Taking this fraction of the velocity of light we have the space traversed by the earth in one second, and by multiplying by the number of seconds in a sidereal year we obtain the dimensions of the annual orbit of the earth. Half the diameter of this orbit is the distance of the sun from the earth. The solar parallax, according to M. Foucault is 8"·86, with an uncertainty of about $\frac{1}{500}$.

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